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INDIAN CORN AND THE INDIAN.

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MAIZE is the product of an ancient American civilization, which if small as compared with that of to-day, yet was capable of achieving results which we of the present gladly appropriate. It constituted the daily food of tribes which have now disappeared from existence, and at the time of the discovery was a cherished plant throughout the temperate and the tropical regions of America, and finds mention in nearly every account of the voyager, or hardy explorer who penetrated beyond the confines of the coast. The plant has never been recorded as being found in a wild state, but has existed in numerous varieties from time immemorial, and the leading races grown to-day can find more or less certain identification in the imperfect descriptions of the species grown by the Indians.

It is a general observation that varieties are produced through the influence of the wants and the choice expressed by civilization, and hence we may conclude that the vast number of varieties of maize that formerly, as now, existed, have been derived through the appreciation of a culture that was under the influence of varied and critical consumers. In Central America the conditions existed for producing varieties, and hence wheresoever the home of the native plant is to be located, from this central region must we preferably look for the origin of the domesticated maize-plant, as we now know it, or at least of some of its races. We have evidence in the tropical nature of the plant that it was originally derived from a country where winters were unknown, or were mild. The few traditions that we have found recorded by the Indians all point towards Central America, as where it is

stated in the Popol Vuh that four barbarians, the Fox, the Jackal, the Paraquet and the Crow, guided to Paxil or Cayala, the "land of divided and stagnant waters" where "the white and the yellow maize did abound," and apparently a civilized country, and where the use of maize for meal and for preparing "nine drinks" was acquired. The Navajoes have the tradition that a turkey hen came to them flying from the direction of the morning star, and shook from her feathers an ear of blue corn (Bancroft, Native Races, III, 83). The Indians of Massachusetts, as Roger Williams writes, have a tradition that the crow brought "them at first an Indian graine of corne in one Eare, and an Indian or French Beane in another, from the great God Kautautowits' field in the Southwest, from whence they hold came all their Corne and Beanes" (Key to the Lang. of Am., 1643, p. 144, Narragansett Club ed.).

The antiquity of maize, as well as its importance, is attested by the circumstance of its connection with religion, and its acquirement of sacred characters. Centeotl, in Mexico, was goddess of maize, and hence of agriculture, and was known, according to Clavigero, by the title, among others, of Tonacajohua, "she who sustains us." Sahagrun writes of the seventy-eight chapels of the great temple at Mexico, that the forty-fifth edifice was called Cinteupan, and therein was a statue of the god of maize. Torquemada also says "there was another chapel dedicated to the god Cinteutl, called Cinteupan, he was the god of maize and of bread," and Charnay (1880), who quotes the above references, found a statue bearing sculptural representations of ears of maize.

The Mexican god Tlaloc is represented by Ixtlilxochitl "in the picture of the month Etzalli with a cane of maize in the one hand and in the other a kind of instrument with which he was digging the ground" (Bancroft, Native Races, III, 325), and varilous ceremonials in relation to maize are recorded by many of the early Spanish writers upon Mexico.

In Peru the maize of Titiaca was considered sacred, and was distributed throughout the kingdom in small parcels to impart a portion of its sanctity to the granary wherein it was stored (Garcilasso, Royal Com. Hak. Soc. ed., I, 288), and in the garden of the Inca: "There was also a large field of maize, the grain they call quinua, pulses, and fruit trees with their fruit; all made

of gold and silver" (*ib.*, I, 283). Acosta also describes ceremonies in which maize took part.

It seems certain that the Indians of America were often agricultural, especially under circumstances where the soil was favorable, and where tribal strength admitted of the protection of their crops, and that maize was cultivated not only sufficient for their own wants but also to admit of furnishing supplies to others in need. We think it well to bring together evidence to this effect connected with the northern portion of our country.

In the Icelandic Saga, in 1006, Karlsefne arrived at a place called Hop, at the mouth of a river, which may as well be the St. Lawrence as any other, as this seems to answer the conditions of the narrative, and "they found there upon the land self sown fields of wheat, there where the ground was low, but vines there where it rose somewhat" (Icelandic Sagas, Prince Soc. ed., p. 54), and "sent out two Scotch people to explore; when they returned they brought back a bunch of grapes, and a new sowen ear of wheat" (Voyages of the Northmen, Prince Soc. Pub., p. 51). "The same year (1002) [Rafn.], sailing from Greenland westward, Thorwald, brother of Lief, reached the wintering place in Vinland [mouth of the St. Lawrence]. The following summer * * * * on an island far westward 'met with a wooden Kornhjalmr,' but saw no other signs of inhabitants, nor of wild beasts" (Pickering Chron. Hist. of Pl., p. 664). In 1535, Jacques Cartier, at Hochelega, now Montreal [the island far westward?], "began to find goodly and large fields, full of such corn as the country yieldeth; it is even as the millet of Brazil, as great and somewhat bigger than small peason, wherewith they live even as we do, with ours" (Pinkerton's Coll. of Voy., XII, 651), and elsewhere he says: "At the top of the houses were garners where they kept their corn, which was something like the millet of Brazil, and called by them *Carracony* (Tytler's Disc. of N. Coast of Am., p. 46), and he further states that the town was situated in the midst of extensive corn fields and the houses were large and commodious (Cartier's Voy. Hak. Coll.). Another name for the corn seemed to have been *offici*, and he also adds: "They have also great store of musk-millons, pompions, gourds, cucumbers, peason and beans of every color, yet differing from ours" (Pinkerton's Voy., XII, 656). In 1613 Champlain found at Lake Coulonge, on the Ottawa river, a crop of maize growing (Park-

man, Pioneers of France, 348) in this northern latitude, and on the Ottawa river, 1632, mentions also pumpkins, beans and French peas obtained recently from the traders (*ib.*, 352).

This year on Lake Huron, Champlain saw fields of maize, idle pumpkins ripening in the sun, and patches of sunflowers (*ib.*, 366). "The Adirondacs," says Colden, "formerly lived 300 miles above Trois Rivers; * * * * at that time they employed themselves wholly in hunting, and the Five Nations made planting of corn their business (Hist. of the Five Nations, Lond., 1747).

In 1615 Champlain invaded the Iroquois country, the present New York, and saw the Iroquois at work among their pumpkins and maize, gathering their harvest, for it was the month of October. In 1653 Le Moyne navigated Lake Ontario, and in the country of the Senecas had given him "bread made from Indian corn, of a kind to be roasted at the fire." In 1687, in an invasion into this country by de Nouville, some 400,000 minots, or 1,200,000 bushels of corn were said to have been destroyed (Doc. Hist. of N. Y., 1, 238); and in 1696, Frontenac, in the country of the Onondagas, spent the 7th, 8th and 9th of August with his army in destroying the growing corn which extended from a league and a half to two leagues from the fort (*ib.*, 1, 212). In 1779, when the army under Gen. Sullivan came to the vicinity of Cayuga and Seneca lakes, they found the lands cultivated, yielding abundant corn, extensive orchards, and a regularity in the arrangements of their houses which announced prosperity and enjoyment of property; the houses were framed and painted and possessed chimneys (Trans. N. Y. Agr. Soc., 1850, 380), and Gen. Sullivan says of the Indians of the Genessee valley that their fields were fruitful with "every kind of vegetable that could be perceived," and another record catalogues "corn, beans, peas, squashes, potatoes, onions, turnips, cabbages, cucumbers, watermelons, carrots and parsnips (Conover's Early History of Geneva, N. Y., p. 47).

When Verrazzano, 1524, visited the New England coast he found the Indians would trade only at a distance, and when he landed he was welcomed with the war-whoop and clouds of arrows. This is worthy of note as showing that the conditions were unfavorable to agriculture. When Capt. John Smith visited the coast he enumerates "pompions, gourds, strawberries, beans, pease and mayze (The Desc. of New England, 1614, p. 16; Peter

Force Coll. of Tracts, II), and mentions "Mattahunts, two pleasant isles of groves, gardens and corne fields a league in the sea from the mayne" (*ib.*, p. 5), and this indicates a change in the local conditions rather than a change of habits in the people. Champlain, in 1605, describes the method of storing maize in large grass sacks buried under ground in dry places, and mentions the methods of field cultivation at the mouth of the Kennebec and Cape Cod, and finally says that after passing Cape Cod they found much land well tilled in corn and other grains (Champlain's Voy., Prince Soc. ed., p. 121, etc.), and in 1636, when the English made an attack on the Indians of Block island, they found "two hundred acres of land were under cultivation, and the maize, already partly harvested, was piled in heaps to be stored away for winter use (Bryant's Hist. of the U. S., II, 4). When the pilgrims first landed they sent out Miles Standish to explore, and "from thence [Truro] we went on, and found much plain ground, about fifty acres, fit for the plough, and some signs where the Indians formerly planted their corn. * * * * We went on further and found new stubble, of which they had gotten corn this year" (Young's Chron. of the Pilg., 130, 132). This same Nov. 16, 1620, they found "divers fair Indian baskets filled with corn, some whereof was in ears, fair and good, of divers colors" (Morton's New Eng.'s Memorial ed., 1826, p. 40), and Mouart says of this corn, "some yellow, and some red, and others mixt with blue" (Mass. Hist. Soc. Coll., Ser. I, VIII, 210). Higginson (1629) mentions also the color of the corn in New England, as "red, blew and yellow, &c.; and of one corne there springeth four or five hundred" (New England's Plantation, 118, Mass. Hist. Soc. Coll.); and Josselyn, before 1670, describes not only corn of various colors, but beans, pumpkins, squashes, etc. Lescarbot (Hist. Nouv. France, ed. 1612) says the Indians of Maine, like those of Virginia and Florida, plant their corn in hills, along with beans.

At first the Swedish settlements at New Jersey and Pennsylvania (1638) were obliged to buy maize of the Indians for sowing and eating (Peter Kalm, Trav.), and in 1633, on the Delaware river, obtained from the Indians corn and peas (Hazard's Annals of Pa., 32). As showing the importance of corn to the Indians, we may note that Rev. John Campanius, in his Delaware and Swedish translation (1696) of the Catechism, accommodates the

Lord's Prayer to the circumstances of the Indian thus: instead of "give us our daily bread," he has it, "a plentiful supply of venison and corn" (*ib.*, 101). In 1609 Hudson mentions "a great quantity of maize" near where is at present Rensselaer county, N. Y.

In Virginia, Grenville, in 1585, "with hasty cruelty ordered the village to be burned, and the standing corn to be destroyed" (Bancroft, Hist. of the U. S., I, 96); Heriot, and Strachey mention maize, as also John Smith and many others, and the method of Indian culture is described in "A True Declaration of Virginia," 1610.

In the expedition of Narvaez to Florida, in 1528, maize was found in abundance. In 1544 the Indian tribes everywhere on the route of De Soto's expedition from Florida to Alabama, Mississippi, Missouri and westward were found to be an agricultural people, subsisting largely upon maize, and in De Bry's collection, 1591, Plate XXI, Vol. II, represents Florida Indians of both sexes engaged in the cultivation of the fields. Indeed, there is hardly an account of Florida in the sixteenth century but what mentions inferentially or otherwise maize, beans and pumpkins as being produced in great abundance.

In 1540 Coronado started from Mexico for an expedition northward, and everywhere, where the soil was suitable, found maize and other products of cultivation, even to his most northern point, which is probably the now State of Kansas, a country "well watered by brooks and rivers, * * * the soil was the best strong black mold, and bore plums like those of Spain, nuts, grapes and excellent mulberries. The inhabitants were savages, having no culture but of maize." Marquette in 1673, Allouez in 1676 and Membrè in 1679 all mention the cultivation of maize by the Illinois Indians, and in 1680 Hennepin found corn everywhere in his journey from Niagara to the Mississippi river.

We have now briefly, by the use of a few only of the authorities at our command, shown the existence of the cultivation of maize throughout a large part of the borders of the present United States. A few more references of a later date may serve to impress the fact that the Indians were anciently an agricultural race where the conditions for agriculture were favorable. In Gen. Wayne's letter to the Secretary of War, August, 1794, he speaks of the Delawares of Ohio: "The margin of those beautiful rivers, the Miami's, of the lake and Au Glaize—appear like one

continued village for a number of miles, both above and below this place; nor have I ever before beheld such immense fields of corn in any part of America, from Canada to Florida." Preceding this account, Carver, the celebrated English traveler, who traveled upwards of 5000 miles of the interior about the period of the Revolutionary war, writes that the Ottagammies, the Saukees and all the Eastern nations, were found growing Indian corn. In 1804 the Sioux of the Upper Missouri were found by Lewis and Clark cultivating corn, beans and potatoes, and indeed the references to Indian cultivation either directly by the observers, or indirectly through antiquarian evidence, place beyond a doubt the existence of an agriculture often more or less rude, often more or less perfect, among the tribes of Northern Indians with irrigated fields and a systematized agriculture among some of the tribes of the Southwest.

Let us note very briefly a few points to show that the Northern Indians were intelligently desirous of securing agricultural products which would add to their luxury or support. We will not refer to the Southern or Nahua tribes, for their possession of maize, beans, pumpkins, sweet potatoes, yams, cassava, chocolate, peppers, tomatoes, etc., etc., in numerous varieties are sufficient evidence of their progress in agriculture, even if we refrain from mentioning the gardens of Mexico and Peru, which antedate the existence of similar institutions in France, if Hallam is to be credited, and in Mexico "flowers were the delight of the people."

The melon is mentioned in 1494 as grown by the companions of Columbus at Isabella island, and this is their first occurrence in America. In 1535 Jacques Cartier speaks of the Indians at Hochelega, now Montreal, as having "great store of muskmilions." In 1540 Lopez de Gomara mentions *melons* as grown at Quivira, in the country of Tiguex, which appears to be somewhere in the region of the present Arkansas, and in 1850 Antonio de Espejo found *melons* cultivated by the Concho Indians. In 1542 the army of the viceroy, sent from Mexico to Cibola, found the melon already there. Indeed melons are mentioned by the early visitors in New England, Virginia, Florida and the West. This rapid distribution of a desirable fruit is strong evidence in favor of the care the Indians gave to their fields, in securing and preserving seed.[1]

[1] We must remember, however, that by the older horticulturists the pumpkin was often called a melon.

Peach stones were among the articles ordered by the Governor and Company of the Massachusetts Bay in New England in 1629. In 1683 Wm. Penn speaks of the Indian orchards of peaches about Philadelphia as bearing great abundance of fruit "not inferior to any peach you have in England, except the true Newington." Hilton, in 1664, speaks of peaches abounding in Florida, and Du Pratz, in his history of Louisiana, 1758, says the natives had doubtless got their peach trees from the English colony of Carolina before the French established themselves in Louisiana, and says that they were of the clingstone variety. In the destruction of the Indian settlement at Geneva, N. Y., by Gen. Sullivan in 1779, peaches are enumerated in Major Beatty's account of a near town called Kershong. Among the Indian products destroyed in this invasion, apple, pear and plum trees are also distinctly mentioned, and so remarkable was the town of Kendaia for its orchards, that it was called Apple-town. Wm. Bartram, in his travels in the South about 1773, speaks of the carefully formed orange groves of the Indians, and in one place of a cultivated plantation of shellbark hickory. The settlers of Michigan, in 1805, found here and there about the State orchards of seedling apple trees planted by the Indians, and which, though of great age, were healthy and productive. We thus see that the Indians were willing to exercise a forethought in growing plants which would produce only a long time after being planted.

The cultivation of the potato was first introduced into New England in 1719, and its growing as a field crop is first mentioned at Salem, Mass., in 1762. In 1779, on the authority of Moses Fellows, sergeant of the 3d N. H. regiment, under Gen. Sullivan, the soldiers destroyed, on Sept. 9, at the present Geneva, N. Y., the crops of the Indians, which included "corn, beans, peas, squashes, *potatoes*, onions, turnips, cabbages, cucumbers, watermelons, carrots and parsnips."

Our citations are sufficient to call attention to the agricultural tendencies of the Indian population of North America, and justify in their analyses our first remark, that where the circumstances of climate and soil were favorable, and where the tribal strength was sufficient to protect the crops, the Indians were apparently a people who might properly be termed agricultural.

It is this agricultural feature of the Indian character which tended to develop the many varieties and agricultural species of

maize. At the time of the discovery of the various regions of our country in detail, the Indians had already accomplished in the matter of improvement of varieties of maize what we are at present using, and we have no evidence, I speak after careful research, that any new forms of maize have appeared from our two centuries or more of civilized cultivation. The various agricultural species of maize, the flints, dents, softs, sweets and pops appear to be original forms; the subdivisions of these into local forms appear to have been about as well accomplished by the Indians as by ourselves. The leading forms of maize, in all the cases where sufficient material has been collected for examination, can be referred to an Indian original, and a more cursory examination into all the forms, seems to indicate that this Indian origin is common with all.

If we ask the maize plants themselves to tell their own story, we have for reply:

We are originally of a warm region, for our seeds require about 80° F. for their best germination, and our roots occupy only the hotter regions of the soil. We are of very ancient origin, and many ages ago separated into several groups, for we now represent five different families, which do not easily fraternize and which resist attempts at mingling, to a more or less extent, but not reciprocally. We have been long domesticated, for we have lost the power of becoming feral, in our civilization we do not recognize our barbarian ancestry even by sight, we have long ago separated into agricultural species for the convenience of man, we have within each of our species given to man's continuous asking varieties suited for his necessities to accompany him to regions of short seasons, and to regions unknown to our ancestry. We have varied for man as he has required new wants of us, yet we have maintained the traditions of our origin, when man has not compelled us to discard. We yet ask the temperature for our growth that our ancestors enjoyed; we yet ask that we shall not be subjected to shade. Upon unessentials we have yielded, perhaps after long repeated persuasion, to mold our product to man's desire for quantity, to change our habit of bearing, to get along with a greater or less continuance of heat, to grow larger or smaller plants, to protect ourselves from the thieving of birds or insects, to abandon those agencies for our own survival, from which care man has relieved us. We now

consider ourselves as respectable and useful among man's companions, and in our habits we would show the generations of culture we have received.

Leaving our plant and returning to human experience, we can summarize our view by saying that the problem of similarity of types with great structural diversity of kernel, is only soluble by influences which have had a very long period of time to work in; and the perfectness of the result attained is to be explained only upon the supposition of a very long period of intelligent selective action. It is very probable that a more intimate acquaintance with the facts concerning the development of a single domesticated plant, as gained from philological, physiological and recorded data will some time or other tend to throw some light upon the antiquity of man and the direction and extent of his migrations.

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ON THE EVOLUTION OF THE VERTEBRATA, PROGRESSIVE AND RETROGRESSIVE.[1]

BY E. D. COPE.

(Continued from page 148, February number.)

III. The Line of the Urochorda.

EMBRYOLOGICAL evidence leads us to anticipate that the primitive Vertebrata possessed nothing representative of the vertebrate skeleton beyond a chorda dorsalis. Above this axis should lie the nervous chord, and below it the nutritive and reproductive systems and their appendages. Such a type we have in its simplest form in the Branchiostoma, the representative of the division of the Acrania. In the animals of this division the mouth and anus have the usual vertebrate position, at opposite ends of the body-cavity. The Tunicata (formerly referred to the Mollusca) are now known to present a still more primitive type of Vertebrata, to which the name of Urochorda has been given. These curious, frequently sessile creatures, have a vertebrate structure during the larval stage, which they ultimately lose. They have the necessary chorda, and nervous axis with a brain, and a cerebral eye. They have at this time a tail, and are free-swimming; a peculiarity which a few of them retain throughout life (Appen-

[1] A lecture delivered before the Franklin Institute, Jan. 16, 1884. (Erratum: on p. 147, 2d line from bottom, omit "Batrachia.")

dicularia).[1] They differ from the Acrania in the positions of the extremities of the alimentary canal. The mouth is on the top of the anterior end of the animal, and is supposed by some anatomists to represent an open extremity of the pineal gland of other Vertebrata; while the tract represented by this body, the third ventricle of the brain, and the pituitary body of the Craniata, are the remains of the primitive œsophagus of the Urochorda. The anus in the adult tunicates is either dorsal, or it opens into the body cavity, as in the young larvæ. In Appendicularia it is ventral (Gegenbaur).

The history of the Tunicata cannot be traced by palæontologists as yet, owing to the absence of hard parts in their structure. The evidence of embryology has, however, convinced phylogenists that the ancestors of this class resembled their larvæ, and that they have as a whole undergone a remarkable degeneracy. They have passed from an active, free life to a sessile one, and have lost the characters which pertain to the life of vertebrates generally.

It was to have been anticipated, however, that all of these ancestral Tunicata did not undergo this degenerative metamorphosis, for it is to such types that we must look for the ancestors of the other Vertebrata, the Acrania and the Craniata. And here palæontology steps in and throws new light on the question. I have pointed out briefly, on another page of the NATURALIST,[2] that a second order must be added to the Urochorda, viz., the Antiarcha, in which the anus presents the same position as in the Acrania, at the posterior end of the body, while an orifice of the upper surface represents the mouth of the Tunicata. To this order is to be referred the family of the Pterichthyidæ, of which the typical genus, Pterichthys, is a well-known form of the Devonian period. This genus retained its tail, which was the cause, in connection with the presence of lateral fin-like appendages, of its having been supposed to be a fish, by Agassiz, Hugh Miller and others. It is possible that the American *Bothriolepis canadensis* lost its tail, as in the majority of Urochorda. The tunicate which approaches nearest to the Antiarcha is the arctic Chelyosoma.

From the Antiarcha to the Acrania and Craniata, then, the line is an ascending one.

[1] See Lankester on Degeneration, Nature Series, 1880.

[2] This (March) number, 1885, under "Geology and Palæontology."

IV. The Line of the Pisces.

The fishes form various series and subseries, and the tracing of all of them is not yet practicable owing to the deficiency in our knowledge of the earliest or ancestral forms. Thus the origins of the four subclasses, Holocephali, Dipnoi, Elasmobranchii and Hyopomata, are lost in the obscurity of the early Palæozoic ages.

A comparison of the four subclasses just named shows that they are related in pairs. The Holocephali and Dipnoi have no distinct suspensory segment for the lower jaw, while the Elasmobranchii and Hyopomata have such a separate element. The latter therefore present one step in the direction of complication beyond the former, but whether the one type is descended from the other, or whether both came from a common ancestor or not, is unknown. If one type be derived from the other it is not certain which is ancestor, and whether the process has been one of advance or retrogression. The fauna of the Permian epoch throws some light on the relations of these subclasses in other respects. The order of the Ichthyotomi,[1] while belonging technically to the Elasmobranchi, presents characters of both the Dipnoi and the Hyopomata. It is so near to the Dipnoi in the characters of the skull that nothing save the presence of a free suspensor of the lower jaw prevents its entering that subclass. It indicates that the one of these divisions is descended from the other, or both from a common division which may well be the group Ichthyotomi itself. In case the Elasmobranchi have descended from the Ichthyotomi, they have undergone degeneracy, as the Ichthyotomi have a higher degree of ossification and differentiation of the bones of the skull. If they descended from a purely cartilaginous type of Dipnoi, they have advanced, in the addition of the free hyomandibular. If the Dipnoi have descended from either division, they have retrograded, in the loss of the free hyomandibular. As regards the Hyopomata, we have a clear advance over the other subclasses in the presence of the maxillary arch and the opercular apparatus.

Too little is known of the history of the subclasses, excepting the Hyopomata, for us to be able to say much of the direction of the descent of their contained orders. On the sharks some light is shed by the discovery of the genus Chlamydoselachus Gar-

[1] See Palæontological Bulletin No. 38, E. D. Cope, 1884, p. 572, on the genus Didymodus.

man,[1] which is apparently nearly related to the Cladodonts of the Devonian seas. This genus has more numerous branchial slits than all but two of the genera of existing sharks, and it differs from all but these two in having a more perfect articulation between the tooth-bearing bones and the cranium. Of the Hyopomata a much clearer history is accessible. It has three primary divisions or tribes which differ solely in the structure of the supports of the fins. In the first division, the Crossopterygia, the anterior limbs have numerous actinosts which are supported on a peduncle of axial bones. The posterior limbs are similar. In the second division, or Chondrostei (the sturgeons, etc.), the posterior limb remains the same, while the anterior limbs have undergone a great abbreviation in the loss of the axial bones and the reduction of the number and length of the actinosts. In the third group, or Actinopteri,[2] both limbs have undergone reduction, the actinosts in the posterior fin being almost all atrophied, while those of the fore limb are much reduced in number.

The phylogeny of these tribes is not easy to make out at present. The descent has been no doubt in the order named in time, but the starting point is yet uncertain. Thus the Chondrostei appear later in time than either of the other tribes, a history which probably only represents our ignorance. The characters of the genus Crossopholis Cope, from the American Eocene, strongly suggests that the existing forms have descended from scaled ancestors. The Crossopterygian fore limb, with its arm-like axis, tells of the origin of the first limbed vertebrates, the Batrachia, whose skull-structure, however, only permits their derivation from the Dipnoi or Holocephali. As the former subclass has the Crossopterygian fin structure, we can safely regard them as the ancestors of the Batrachia, while the Crossopterygia are a side line from a similar type, probably the Ichthyotomi, because these have a free suspensor of the lower jaw. But of the structure of the fins of the Ichthyotomi unfortunately we know nothing. If this position be true, then the successive derivation of the Chondrostei and the Hyopomata in one line is rendered probable. The modification of structure has consisted in the contraction of the supporting elements of the pectoral and ventral fins by the reduction of their numbers and length. According to palæontological

[1] Proceedings American Assoc. Adv. Sci., 1884.

[2] Partly agrees with the Teleostei of Müller, but includes many of his Ganoidea.

history, however, the tribe with most contracted fins, Actinopteri, appeared in the Coal measures (Paleoniscidæ), or very soon after the Crossopterygia in the Devonian.

The descent of the fishes in general has witnessed, then, a contraction of the limbs to a very small compass and their substitution by a system of accessory radii. This has been an ever widening divergence from the type of the higher Vertebrata, and from this standpoint, and also a view of the "loss of parts without complementary addition of other parts," may be regarded as a process of degradation.

Taking up the great division of the Actinopteri, which embraces most of the species of living fishes, we can trace the direction of descent largely by reference to their systematic relations when we have no fossils to guide us.

The three subtribes adopted by Jordan represent three series of the true fishes which indicate lines of descent. The Holostei include the remainder of the old ganoids after the subtraction of the Crossopterygia and the Chondrostei. They resemble these forms in the muscular bulbus arteriosus of the heart and in the chiasm of the optic nerves. Both of these characters are complexities which the two other divisions do not possess, and which, as descendants coming later in time, must be regarded as inferior, and therefore to that extent degenerate. Of these divisions the Physostomi approach nearest the Holostei, and are indeed not distinctly definable without exceptions. The third division, or Physoclysti, shows a marked advance beyond the others in: (1) The obliteration of the primitive trachea, or ductus pneumaticus, which connects the swim-bladder and œsophagus; (2) the advance of the ventral fins from the abdomen forwards to the throat; (3) the separation of the parietal bones by the supraoccipital; (4) the presence of numerous spinous rays in the fins; and (5) the roughening of the edges of the scales, forming the ctenoid type. There are more or less numerous exceptions to all of these characters. The changes are all further divergences from the other vertebrate classes, or away from the general line of ascent of the vertebrate series taken as a whole. The end gained is specialization, but whether the series can be called either distinctively progressive or retrogressive is not so clear. The development of osseous spines, rough scales, and other weapons of defense, together with the generally superior energy and tone which prevail

among the Physoclysti, characterize them as superior to the Physostomi, but their departure from the ascending line of the Vertebrata has another appearance.

The descent of the Physoclystous fishes has probably been from Holostean ancestors, both with and without the intervention of Physostomous forms. This is indicated by increase in the number of actinosts in the fins of families which have pectoral ventral fins, as in the extinct genus Dorypterus.[1]

The Physostomi display three or four distinct lines of descent. The simplest type is represented by the order Isospondyli, and palæontology indicates clearly that this order is also the oldest, as it dates from the Trias at least. In one line the anterior dorsal vertebræ have become complicated, and from an interlocking mass which is intimately connected with the sense of hearing. This series commences with the Characinidæ, passes through the Cyprinidæ, and ends with the Siluridæ. The arrangements for audition constitute a superadded complication, and to these are added in the Siluroids defensive spines and armor. Some of this order, however, are distinctly degenerate, as the soft purblind Ageniosus, and the parasitic Stegophilus and Vandellia which are nearly blind, without weapons, and with greatly reduced fins.

The next line (the Haplomi, pike, etc.) loses the præcoracoid arch and has the parietal bones separated, both characters of the Physoclysti. This group was apparently abundant during the Cretaceous period, and it may have given origin to many of the Physoclysti.

Another line also loses the præcoracoid, but in other respects diverges totally from the Physoclysti and all other Physostomi. This is the line of the eels. They next lose the connection between the scapular arch and the skull, which is followed by the loss of the pectoral fin. The ventral fin went sooner. The palatine bones and teeth disappear, and the suspensor of the lower jaw grows longer and loses its symplectic element. The opercular bones grow smaller, and some of them disappear. The ossification of most of the hyoid elements disappears, and some of their cartilaginous bases even vanish. These forms are the marine eels or Colocephali. The most extraordinary example of specialization and degeneracy is seen in the abyssal eels of the family Eurypharyngidæ. Here all the degenerate features above

[1] See Proceeds Amer. Assoc Adv. Science, 1878, p. 297.

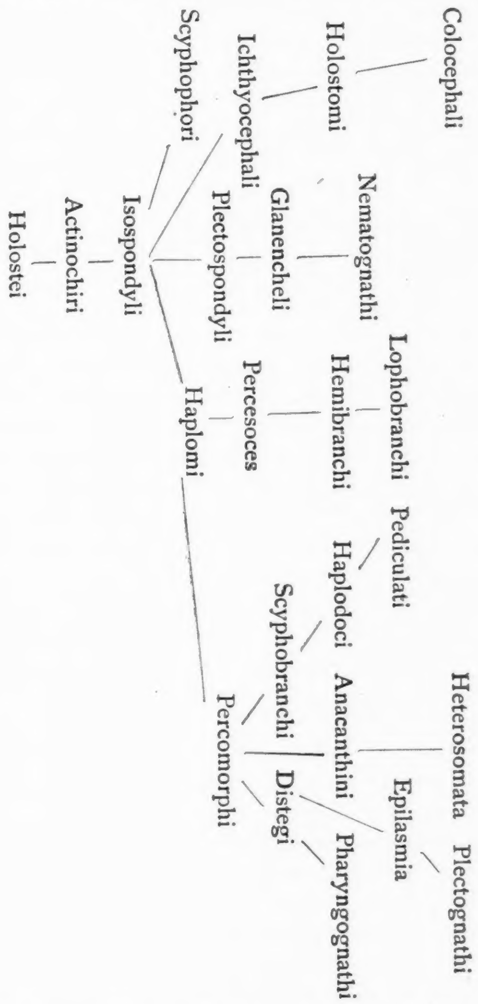
mentioned are present in excess, and others are added, as the loss of ossification of a part of the skull, almost total obliteration of the hyoid and scapular arches, and the semi-notochordal condition of the vertebral column, etc.

The Physoclysti nearest the Physostomi have abdominal ventral fins, and belong to several orders. It is such types as these that may be supposed to have been derived directly from Holostean ancestors. They appear in the Cretaceous period (Dercetidæ), along with the types that connect with the Physostomi (Haplomi). Intermediate forms between these and typical Physoclysti occur in the Eocene (Trichophanes, Erismatopterus), showing several lines of descent. The Dercetidæ belong apparently to the order Hemibranchi, while the Eocene genera named belong apparently to the Aphododiridæ, the immediate ancestor of the highest Physoclysti, the Percomorphi. The order Hemibranchi is a series of much interest. Its members lose the membrane of their dorsal spinous fin (Gasterosteidæ), and then the fin itself (Fistularia, Pegasus). The branchial apparatus has undergone, as in the eels, successive deössification (by retardation), and this in direct relation to the degree with which the body comes to be protected by bony shields, reaching the greatest defect in the Amphisilidæ. One more downward step is seen in the next succeeding order of the Lophobranchii. The branchial hyoid apparatus is reduced to a few cartilaginous pieces and the branchial fringes are much reduced in size. In the Hippocampidæ the caudal fin disappears and the tail becomes a prehensile organ by the aid of which the species lead a sedentary life. The mouth is much contracted and becomes the anterior orifice of a suctorial tube. This is a second line of unmistakable degeneracy among true fishes.

The Physoclysti with pectoral ventral fins present us with perhaps ten important ordinal or subordinal divisions. Until the palæontology of this series is better known, we shall have difficulty in constructing phylogenies. Some of the lines may, however, be made out. The accompanying diagram will assist in understanding them.

The Anacanthini present a general weakening of the organization in the less firmness of the osseous tissue and the frequent reduction in the size and character of the fins. The caudal vertebræ are of the protocercal type. As this group does not appear

early in geological time, and as it is largely represented now in the abyssal ocean fauna, there is every reason to regard it as a degenerate type. The Scyphobranch line presents a specializa-



tion of the superior pharyngeal bones, which is continued by the Haplodoci (Batrachidæ). This cannot be called a degenerate line, although the fin-rays are soft. The Heterosomata (flounders)

found it convenient to lie on one side, a habit which would appear to result from a want of motive energy. The fins are very inefficient organs of movement in them, and they are certainly no rivals for swift-swimming fishes in the struggle for existence, excepting as they conceal themselves. In order to see the better while unseen, the inferior eye has turned inwards, *i. e.*, upwards, and finally has penetrated to the superior surface, so that both eyes are on one side. This peculiarity would be incredible if we did not know of its existence, and is an illustration of the extraordinary powers of accommodation possessed by nature. The Heterosomata can only be considered a degenerate group.

The double bony floor of the skull of the Distegous percomorph fishes is a complication which places them at the summit of the line of true fishes. At the summit of this division must be placed the Pharyngognathi, which fill an important role in the economy of the tropical seas, and the fresh waters of the Southern hemisphere. By means of their powerful grinding pharyngeal apparatus they can reduce vegetable and animal food inaccessible to other fishes. The result is seen in their multifarious species and innumerable individuals decked in gorgeous colors, and often reaching considerable size. This is the royal order of fishes, and there is no reason why they should not continue to increase in importance in the present fauna.

Very different is the line of the Plectognathi. The probable ancestors of this division, the Epilasmia (Chætodontidæ, etc.), are also abundant in the tropical seas, and are among the most brilliantly colored of fishes. One of their peculiarities is seen in a shortening of the brain-case and prolongation of the jaws downwards and forwards. The utility of this arrangement is probably to enable them to procure their food from the holes and cavities of the coral reefs among which they dwell. In some of the genera the muzzle has become tubular (Chelmo), and is actually used as a blow-gun by which insects are secured by shooting them with drops of water. This shortening of the basicranial axis has produced a corresponding abbreviation of the hyoid apparatus. The superior pharyngeal bones are so crowded as to have become a series of vertical plates like the leaves of a book. These characters are further developed in the Plectognathi. The brain-case is very small, the face is very elongate, and the mouth is much contracted. The bones surrounding it in each jaw are coössified.

The axial elements (femora) of the posterior fins unite together, become very elongate and lose the natatory portion. In one group (Orthagoriscidæ) the posterior part of the vertebral column is lost and the caudal fin is a nearly useless rudiment. In the Ostraciontidæ (which may have had a different origin as the pharyngeal bones are not contracted), the natatory powers are much reduced, and the body is enclosed in an osseous carapace so as to be capable of very little movement. The entire order is deficient in osseous tissue, the bones being thin and weak. It is a marked case of degeneracy.

There are several evident instances of sporadic degeneracy in other orders. One of these is the case of the family of the Icosteidæ, fishes from deep waters off the coast of California. Although members of the Percomorphi, the skeleton in the two genera Icosteus and Icichthys is unossified, and is perfectly flexible. Approximations to this state of things are seen in the parasitic genus Cyclopterus, and in the ribbon fishes, Trachypteridæ.

Thus nearly all the main lines of the Physoclysti are degenerate; the exceptions are those that terminate in the Scombridæ (mackerel), Serranidæ, and Scaridæ (Pharyngognathi).

V. The Line of the Batrachia.

We know Batrachia first in the coal measures. They reach a great development in the Permian epoch, and are represented by large species in the Triassic period. From that time they diminish in numbers, and at the present day form an insignificant part of the vertebrate fauna of the earth. The history of their succession is told by a table of classification, such as I give below:

I. Supraoccipital, intercalary and supratemporal bones present. Propodial bones distinct.

Vertebral centra, including atlas, segmented, one set of segments together supporting one arch.. *Rachitomi.*

Vertebræ segmented, the superior and inferior segments each complete, forming two centra to each arch.. *Embolomeri.*

Vertebral centra, including atlas, not segmented, one to each arch..... *Stegocephali.*

II. Supraoccipital and supratemporal bones wanting. Frontal and propodial bones distinct.

a. An os intercalare.

A palatine arch and separate caudal vertebræ.......................... *Proteida.*

aa. No os intercalare.

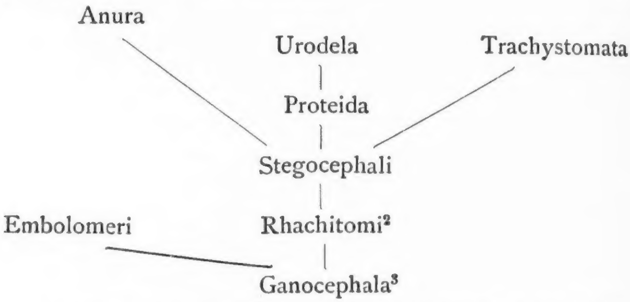
A maxillary arch; palatine arch imperfect; nasals, premaxillaries and caudal vertebræ distinct...*Urodela*.[1]

No maxillary or palatine arches; nasals and premaxillary, also caudal vertebræ, distinct...*Trachystomata*.

III. Supraoccipital, intercalare and supratemporal bones wanting. Frontals and parietals connate; propodial bones and caudal vertebræ confluent.

Premaxillaries distinct from nasals; no palatine arch; astragalus and calcaneum elongate, forming a distinct segment of the limb.......................*Anura*.

The probable phylogeny of these orders as imperfectly indicated by palæontology is as follows:



An examination of the above tables shows that there has been in the history of the Batrachian class a reduction in the number of the elements composing the skull, both by loss and by fusion with each other. It also shows that the vertebræ have passed from a notochordal state with segmented centra, to biconcave centra, and finally to ball and socket centra, with a great reduction of the caudal series. It is also the fact that the earlier forms (those of the Permian epoch) show the most mammalian characters of the tarsus and of the pelvis.[4] The later forms, the salamanders, show a more generalized form of carpus and tarsus and of pelvis also. In the latest forms, the Anura, the carpus and tarsus are reduced through loss of parts, except that the astragalus and calcaneum are phenomenally elongate. We have then, in the Batrachian series, a somewhat mixed kind of change; but it principally consists of concentration and consolidation of parts. The question as to whether this process is one of progression or

[1] Probably includes the Gymnophiona.

[2] Includes the Eryopidæ.

[3] Includes Trimerorhachidæ and Archegosauridæ.

[4] The tarsus of Eryops is much like that of the Theromorph reptiles. See Proceeds. Amer. Philos. Soc., 1884, p. 38.

retrogression may be answered as follows: If degeneracy consists in "the loss of parts without complementary addition of other parts," then the Batrachian line is a degenerate line. This is only partly true of the vertebral column, which presents the most primitive characters in the early, Permian, genera (Rhachitomi). If departure from the nearest approximation to the Mammalia is degeneracy, then the changes in this class come under that head. The carpus, tarsus and scapular and pelvic arches of the Rachitomi are more mammalian than are those of any of their successors.

There are several groups which show especial marks of degeneracy. Such are the reduced maxillary bones and persistent gills of the Proteïda; the absence of the maxillary bones and the presence of gills in the Trachystomata; the loss of a pair of legs and feebleness of the remaining pair in the sirens; and the extreme reduction of the limbs in Amphiuma. Such I must also regard, with Lankester, the persistent branchiæ of the Siredons. I may add that in the brain of the Proteïd Necturus the hemispheres are relatively larger than in the Anura, which are at the end of the line.

It must be concluded, then, that in many respects, the Batrachia have undergone degeneracy with the passage of time.

VI. The Reptilian Line.

As in the case of the Batrachia, the easiest way of obtaining a general view of the history of this class is by throwing their principal structural characters into a tabular form. As in the case of that class I commence with the oldest forms and end with the latest in the order of time, which, as usual, corresponds with the order of structure. I except from this the first order, the Ichthyopterygia, which we do not know prior to the Triassic period:[1]

A. Extremities not differentiated in form beyond proximal segment.

I. Os quadratum immovably articulated to squamosal, etc.

Tubercular and capitular rib articulations present and distinct . . . 1. *Ichthyopterygia*.

AA. Elements of extremities differentiated.

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[1] Generally similar to the system published by me. Proceedings Amer. Ass. Adv. Science, XIX, p. 233.

II. Os quadratum immovably articulated; capitular and tubercular rib-articulations distinct. Archosauria.

Pubis and ischium united, and with little or no obturator foramen; one posterior cranial arch; limbs ambulatory; a procoracoid ....2. *Theromorpha.*
Ischium and pubis distinct, the latter directed forwards, backwards or downwards; two posterior cranial arches; limbs ambulatory; no procoracoid . 3. *Dinosauria.*[1]
Ischium and pubis united; two postcranial arches; anterior limbs volant 4. *Ornithosauria.*

III. Os quadratum closely united to cranial arches; but one rib-articulation. Synaptosauria.

Distinct hyposternal and postabdominal bones; ribs joining each two vertebræ, and generally forming a carapace; one posterior cranial arch......5. *Testudinata.*
Hyposternal and postabdominal bones not distinct; two posterior cranial arches; ribs attached to one vertebra; a sternum; ? no procoracoid 6. *Rhynchocephalia.*
Hyposternal and postabdominal bones not distinct; two posterior cranial arches; ribs attached to one centrum; no sternum[2]; a procoracoid ...7. *Sauropterygia.*

IV. Os quadratum attached only at the proximal extremity, and more or less movable; ribs with one head. Streptostylica.[3]

Brain case membranous in front of proötic bone; trabecula not persistent 8. *Lacertilia.*
Brain case with osseous walls anterior to proötic; a scapular arch and sternum 9. *Pythonomorpha.*[4]
Brain case with osseous walls anterior to proötic; no scapular arch nor sternum; trabecular grooves of sphenoid and presphenoid bones...........10. *Ophidia.*

An inspection of the characters of these ten orders, and their consideration in connection with their geological history will give a definite idea as to the character of their evolution. The history of the class, and therefore the discussion of the question, is limited in time to the period which has elapsed since the Permian epoch inclusive, for it is then that the Reptilia enter the field of our knowledge. During this period but one order of reptiles inhabited the earth, so far as now known, that of the Theromorpha. The important character and role of this type may be inferred from the fact that they are structurally nearer to both the Batrachia and the Mammalia than any other, but present characters which render it probable that all the other reptiles, with possibly the exception of the

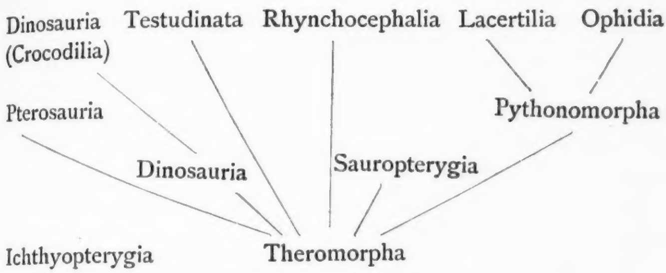
[1] This definition includes the Crocodilia in the Dinosauria, as it is absolutely connected with the typical Dinosaurs by the Opisthocœla (Sauropoda Marsh).

[2] Episternum present.

[3] It is quite possible that the three divisions of this head form one natural order, the Streptostylica, or Squamata.

[4] Including Choristodera, see AMERICAN NATURALIST, 1884, p. 815.

Ichthyopterygia, derived their being from them. The phylogeny may be thus expressed:



(To be continued.)

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ON THE LARVAL FORMS OF SPIRORBIS BOREALIS DAUDIN.

BY J. WALTER FEWKES.

NATURALISTS who are engaged in the identification of the larval forms which marine animals pass through in their growth from the egg, find great difficulty in this study from the lack of direct observations in raising these larvæ from the eggs or in rearing them directly into the adult. This is particularly true in regard to the young of marine annelids, a most profitable field for new observations and one which has had but few cultivators among American naturalists. The following paper is offered as a help to those engaged in this study and not as an extended account of the embryology of the animal of which it treats. It is especially intended for those who are interested in the identification of our marine annelid larvæ.[1]

A genus of chætopod annelids called Spirorbis, as is well known, in its adult and older larval stages, secretes a coiled calcareous case, commonly called its shell, in which it lives. This case is permanently cemented or attached to some foreign body, from which fact the adult is incapable of locomotion. Not so, however, the larva, which is destitute of any such shell, is not fixed but is free swimming, and often captured with the dip-net in surface fishing. From the great dissimilarity in outward form as

[1] The observations here recorded were made in the Zoölogical Laboratory at Newport, R. I. I am indebted to Mr. A. Agassiz for facilities to carry on my studies at that place.

well as the different habitat of the young and adults, the free-swimming larva is often unrecognized or not connected with the genus of which it is the young.

I have often, in former years, captured the larval Spirorbis by surface fishing, but up to a short time ago have been unable to discover to what adult it belongs. Last summer I was fortunate enough to raise these larvæ from the eggs, and am now able to state definitely most of the changes in external form which Spirorbis goes through between the last stages of the segmentation of the egg and the time when it fastens itself to some foreign object and begins its sessile and adult life.

The eggs of *Spirorbis borealis* are easily obtained in considerable numbers. If live adults, enclosed in their cases, be placed in a proper receptacle in water, and the calcareous shells crushed, among the fragments there will be found chains composed of bead-like strings of ova strung along together. These chains are easily distinguished from the other soft parts of the Spirorbis body by their brown or red color. I found a good way to obtain the eggs was to place a number of Spirorbes in a watch crystal with water and then crush the cases with a spatula. Remove the fragments of shells and the strings of eggs are easily seen at the bottom of the watch crystal.

As the adult Spirorbis is very hardy the young can easily be raised from the adult by keeping the latter in an aquarium for a few days, when multitudes of the young make their way out of the worm cases and can be easily found swimming at or near the surface of the water in which they are kept. The young from which the present studies were made were taken in the months of July and August, 1884.

The eggs of *Spirorbis borealis* have a reddish-brown color and are arranged side by side in short strings composed of from one to four rows of from ten to fifteen or more eggs each. The later stages in the segmentation of the egg resemble those of other chætopod eggs and can easily be studied in strings taken from the Spirorbis cases. The younger stages of the segmentation were not found. Each egg is enclosed in a membranous sac, while all the ova lie in a common digitiform structure binding them together. The earliest stages in the development of the larva are passed through while the eggs are thus enclosed.

It will be observed that the larvæ of Spirorbis now to be de-

scribed differ in some particulars from those of "*S. spirillum* Gould (non Pagenst.; an Lam.?)," described by A. Agassiz (*Ann. Lyc. Nat. Hist.*, VIII, pp. 318–323). They differ even more widely from the young of *S. spirillum* described by Pagenstecher (*Zeit. f. Wiss. Zool.*, XII). I regard my larvæ of the same species as that described as *S. spirillum* by Augustus A. Gould (Report on the Invertebrata of Massachusetts [first edition], Boston, 1841).

A. Agassiz says of *S. spirillum* (*op cit.*, p. 318): "The eggs, of a dark reddish-brown color, are found in strings formed of two rows (fig. 18), either on each side of the alimentary canal in the anterior part of the body, where in the adult we find a considerable space free of bristles (as in fig. 25), or else when the strings have been laid they are found on the sides of the body, between it and the limestone tube, and here the young undergo their transformations." Later he says: "The young are quite advanced within the body of the parent previous to the transfer of the egg-sacs to the cavity of the tube where they complete the greater part of their growth." In his figure 18 the larvæ in the strings have already well formed eye spots. I have never been able to observe these larvæ in stages of development in the body of the parent, but have found many specimens of eggs outside the walls of the body of the adult, which were in the last stages of segmentation and therefore much younger than those figured by him (fig. 18).

In the first or youngest stage after segmentation a larval condition was observed in which the embryo almost wholly fills the egg capsule and presents very little differentiation in different regions. This embryo is of an oblong shape and is girt equatorially by a ring of cilia. On one side just below this ciliated belt the wall of the embryo is flattened. The body is opaque, has a dark brown or reddish color, and is destitute of eye spots.

In the next oldest stage (Fig. 1), which is very similar to the young of the genus Pileolaria, figured by Salensky (Etude sur le Developpement des Annelides, Pl. IV, Fig. 7), we have a central, opaque yolk-mass surrounded by a more transparent layer of cells which is thickest on the same side as the flattening noticed in the walls of the larva in a previous stage, a pair of eye spots and a crescentic-shaped body, which is probably lens-shaped when seen in another view, lying between the outer layer of the embryo and its inner cell contents. The external layer I have followed Salensky in regarding as the epiblast and the thin intermediate layer the

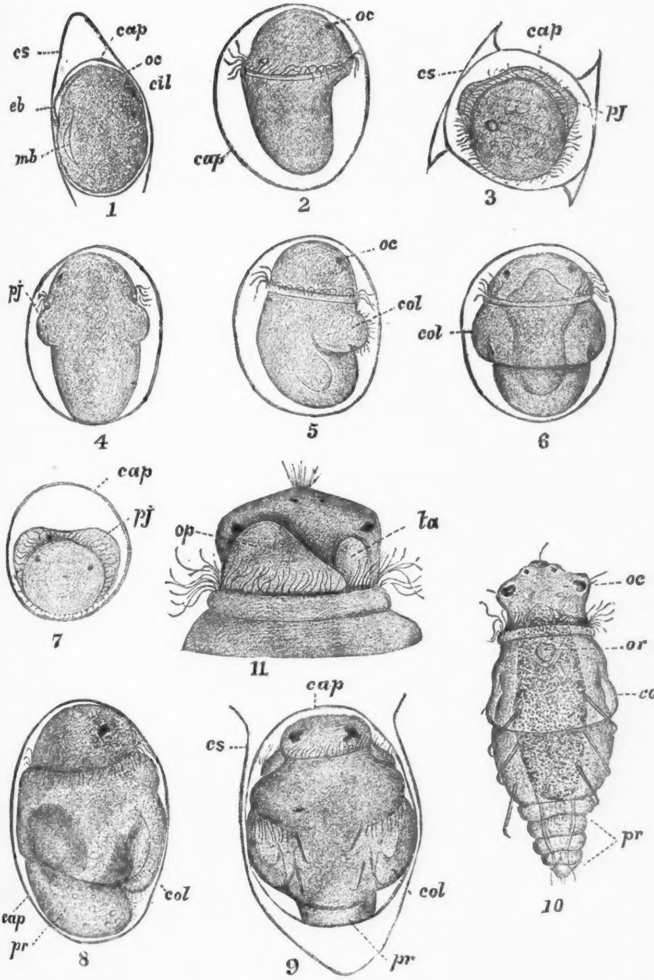
mesoblast. The ring of cilia is seen in profile on each side above the equator of the embryo.

One of the best eggs to use in following the changes has been found to be the last of the chain, since it is always isolated, on one side at least, from the rest. We often find strings of ova with the eggs in a single row. These eggs have always been found well suited for study on account of this simple arrangement. The members of a chain can also be separated from each other without injury.

In the next oldest larva to that just mentioned (Figs. 2, 3, 4), we find the indentation on the flattened side of the embryo still more pronounced than before, as shown in Fig. 2, which represents the larva as seen from one side. If this larva is seen from the posterior pole (Fig. 3), we notice two prominent protuberances which impart to it as seen in this way an irregular triangular shape. From the ventral side (Fig. 4), upon which the protuberances lie, these appendages appear as small lateral projections (*pj*) on each side. The embryo fills almost the whole interior of the capsule in which it is now confined, and the protuberances lie just below the ring of vibratile cilia. From this stage it seems that the collar which is later found on the ventral side of the larva originates as two projections, one on each side. In a larva somewhat older than the last (Figs. 5, 6, 7), the collar (*col*) has formed by the union of the two projections, and has grown somewhat downward over the ventral side of the posterior region of the body. Fig. 7 shows the same embryo as seen from the anterior pole, and Fig. 6 the same from the ventral side. The dorsal surface of the larva is more curved than in younger embryos.

In Fig. 9 the larva is still enclosed in its capsule, and is represented from the ventral region, while the collar is still more developed, and two pairs of single spines were observed in the region partially covered by the collar.[1]

[1] Pagenstecher describes and figures (*op. cit.*, Pl. XXXIX, Fig. 6) a first pair of spines consisting of three on each side at the base of the collar which I have not found in my larvæ. He says, "An der Wurzel des Kragens sprosst das erste Paar von Borstenbündeln hervor, vorläufig mit je drei Borsten." I do not find these represented in the young of *Spirorbis borealis*, and A. Agassiz neither mentions nor figures them in his Spirorbis. My observations do not agree with those of Pagenstecher when he says, "Die erste Spur der Tentacle zeigt sich in Form von drei Höckern jederseits auf dem Kopflappen." I have also been unable to find in my species the oval, green spots, "ovalen gelben Fleck," which he describes "neben dem Magen rechts und links."



Larval forms of *Spirorbis borealis*.

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Fig. 9 is the youngest stage of development of Spirorbis in which lateral spines were observed, and in it there are two pairs, a single spine on each side in each pair. This character is also recorded in one of the larval stages observed by A. Agassiz, he says: "The bristles make their appearance in figure 21, where we find two of the three bundles of the collar-like projection of the anterior extremity always distinctly marked in such young embryos." In figs. 4 and 5, Pl. XXXIX, in Pagenstecher's account, it appears in the youngest stage that the spines are represented by a single pair.

The larva in my plate (XI, Fig. 8) is represented as divided into three marked regions, which from now on will be known as the anterior or cephalic, the middle covered on its ventral side by a much larger growth of the collar and a smaller posterior region. The first and second of these divisions are separated by a ring of cilia, the second and posterior by the posterior border of the collar. The prominent lateral ocellus lies on the ventral side of the larva and has a bright red color. The whole body of the embryo is reddish, while the external surface of the collar as well as the ventral region of the posterior part of the embryo is covered with small cilia. On the walls of the ventral region just below the collar there arises a brick-red projection. I have homologized this projection with the "glandes tubipares" described by Salensky in the young of the genus Pileolaria. In this latter genus, however, these glands are arrayed laterally instead of medially and ventrally. In Spirorbis as in Pileolaria I find three ciliated regions which we may follow Salensky in designating: 1. Couronne ciliaire. 2. Couronne ciliaire abdominale. 3. Couronne ciliaire anale.

The interior of the larva on the dorsal side is occupied by a brownish body which is in part the unabsorbed yolk mass.

Through all the stages of growth thus far traced the embryo is still included in its egg capsule. It was observed to fret continually against its envelope and with its spines it constantly presses upon the walls of the same. The motion of these spines shows at once that the egg capsule has flexible walls yielding easily to such pressure. In the next stage (Fig. 10) the larva has become free from the capsule, swimming about in the water with considerable activity. Judging from A. Agassiz's statement in regard to the amount of the development of the side branches of the tentacles,

the young of the Spirorbis which he studied leaves the egg capsule with its cephalic appendages much more developed than I have observed them to be in *S. borealis*. No branching appendages were seen in the youngest larvæ found free in the water in my specimens.

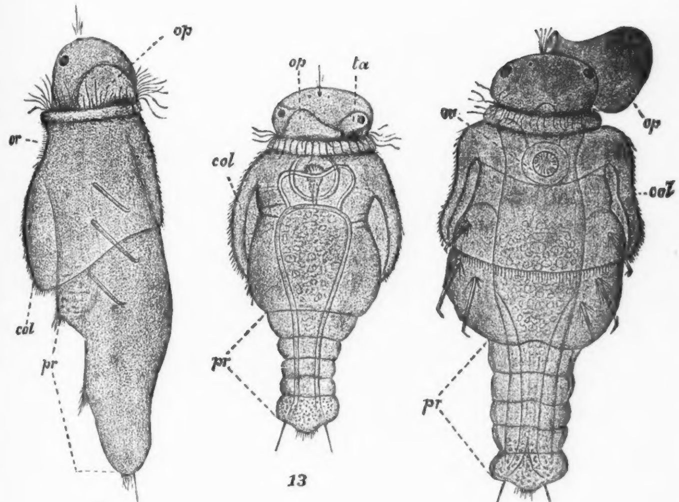
The free larva seen from the ventral side is represented in Fig. 10. It is easily detected in the water on account of its reddish color, although its size is not more than 1^{mm} in length. The larva is more elongated and more vermiform than in previous conditions, and the middle body region is relatively much larger than formerly. It is no longer bounded posteriorly by the posterior edge of the collar.

The head bears four[1] eye spots; two larger, the original ocelli (*oc*), and two small, which are apical, dorsally and medially placed. There is an apical tuft of cilia. The cilia of the belt, between the head and body, are borne on a ferrule-shaped structure which separates the head from the middle body region, and which bears a small ring of cilia on its posterior, a larger on its anterior edge. The mouth opens medially just below this ferrule and above the base of the ventral collar. Its lips are richly ciliated. The ventral collar covers about one-third the middle body region, which is not segmented and bears three pairs of single spines which are falciform at their free extremity. The middle region may be homologized with the anterior body region of such a worm as Prionospio.

The posterior body region is of smaller diameter than the middle and is obscurely segmented. It is ciliated on the ventral side, a prominent ring, "couronne ciliaire abdominale," being formed on the segment nearest the middle division. The posterior extremity of the larva is richly ciliated and bears several short stiff hairs. The whole body cavity, with the exception of that found in the posterior region, has a brick red color. When this larva is seen in profile it will be noticed that the external surface of the collar is ciliated over its whole extent, and that the prominent red projection on the ventral surface of the middle region is also

[1] Pagenstecher says (*op. cit*, p. 492): "Um diese Zeit bilden sich aus einigen Zellen der äusseren Schicht des vordersten Lappens vier Augenpunkte, von denen die hinteren grösser sind, und auf der Mitte der Stirn wachst eine erst ungemein Classe gerade Borste hervor."

A. Agassiz says: "The ocular spots are always limited to two." The larvæ which I have studied have four and a median flagellum, as described by Pagenstecher.



Larval forms of *Spirorbis borealis*.

MIAMI UNIVERSITY.

covered with cilia. Midway between this last and the posterior extremity of the body is a second prominent tuft, and the very end has a third. Besides these three ciliated regions the whole ventral surface of the posterior part of the body of the larva is clothed with small cilia.

If the cephalic region of the last mentioned larva be looked at from one side (Fig. 12), it will be noticed that on the left hand side of it, snugly approximated to the dorsal walls of the head, there is a thin triangular plate which has begun to push itself up from the region just in advance of the ferrule-like structure upon which the ring of larger cilia is borne. This structure which at first grows out from the left hand side of the neck, and is unpaired is the future operculum.[1] At the time of its origin it is small, and in all stages unpaired, while later in the growth of the worm it assumes a considerable size.

The first appendage to form on the right hand side (Fig. 11) of the larva is a small tentacle, short, stout and club-shaped. I do not find another similar tentacle on the left hand side, but if it exists it may be hidden by the operculum. The better interpretation, however, is, that the operculum where it originates has the form of a simple tentacle with which it is strictly homologous; while the size of the operculum as it grows increases so greatly that it far outmeasures that of the right hand tentacle. My observations do not lead me to think that the tentacles form alternately on the sides of the head of this species of Spirorbis.

Fig. 13 represents a slightly older larva seen from the dorsal side, in which the segmentation of the posterior body region is more sharply defined, and in which also the operculum (*op*) and the right hand tentacle (*ta*) are well developed. In Fig. 14 we have the same larva much older, shown from the ventral side, where the operculum is represented as expanded on the left hand side of the head. In most particulars this larva closely resembles the free larva (Fig. 10).

In a stage which is older than the last the larva has passed into a condition in which not only has the operculum assumed a considerable size, but also several small appendages are found on the head, while of the organs of the head which have disap-

[1] In *S. spirillum*, according to A. Agassiz, "the first tentacle appears on the right, next comes the corresponding tentacle of the left, and only later the rudiment of the odd opercular tentacle covering in figure 21 the right tentacle." The operculum was the first cephalic appendage which was observed in the larvæ which I studied.

peared, the most important is a pair of the ocelli, the first to originate and for a long time the most prominent eye spots found on the ventral cephalic prominences. The apical ciliated tuft of former stages has also disappeared. The apical eye spots still remain.

Of the appendages to the head we notice on the right hand side instead of the club-shaped tentacle which formerly existed there, that the place is now occupied by an elongated body with beginnings of side branches, a structure which later forms a branchia. On the left hand side, near the operculum, are small projections which later develop into the left hand branchia, while medially appear two prominences, one upon the other. In the development of the larva of Spirorbis it looks as if we had, as I have already shown,[1] in a larva which is provisionally identified as the immature Prionospio, and as Salensky has found in Pileolaria, temporary cephalic tentacles which later give place to the permanent branchiæ of the head. In the right hand branchia, now of considerable size, we formerly had a small tentacle which, although it never reaches the great size of the temporary tentacle of Prionospio, is so closely similar both in size and general appearance to the temporary tentacle of Pileolaria, as described by Salensky, that it is in Spirorbis placed in the same category.[2]

The passage of the free larva of Spirorbis into the form with a case is a most interesting process, and one which is by no means simply in the changes involved. It can easily be observed in early conditions and the interior even of the larva studied, since the external case, when first formed, is almost wholly transparent.

At this age the larva becomes attached to the walls of the vessel in which it is confined preparatory to the secretion of a shell. In many specimens, however, the following condition, which although probably abnormal, was most advantageous to a study of the secretion of the tube, was observed. The free larva often

[1] Bull. Mus. Comp. Zoöl., Vol. XI, No. 9.

[2] I do not consider that the worm represented in fig. 57 of A. Agassiz's paper (*op. cit.*) is, when compared with fig. 56, an instance of retrograde development. Fig. 57 bears a strong likeness to *Alaurina prolifera* commonly looked upon not as an annelid but as a turbellarian. If the worm is an Alaurina I cannot regard the larva represented in fig. 56 as its young. The adult of fig. 56 is unknown, and it is extremely doubtful that it ever loses its cephalic spines and appendages and passes into fig. 57. It may or may not resemble Prionospio in a subsequent modification of the cephalic tentacles into branchiæ.

does not immediately settle to the bottom prior to the secretion of the case in which it lives, but passes through preliminary stages while floating on the water. Upon the surface of my aquaria, with its Spirorbis, I found a multitude of small white bodies, unattached, which on close examination were found to be Spirorbis larvæ in which the shell had just begun to be secreted. They float on the surface for a short time until the increasing specific gravity of their bodies sinks them to their future homes.

Fig. 15 represents an example of a larva of this kind in which the head and collar is half protruded outside of the cavity of the case in which the larva is found. The head and branchial appendages occupy the middle of the figure at the top, while the expanded trumpet-shaped structure below it is the half protruded collar. It is extremely difficult to draw accurately the outlines of a specimen of Spirorbis in this stage when wholly or partially expanded and alive, from the fact that the movements are so quick in retracting itself into the case, and the animal is so sensitive to any small motion in the immediate vicinity. It has been almost impossible for me to observe the expanded Spirorbis long enough to draw anything more than a simple outline with the camera. This difficulty increased with the growth in age of Spirorbis.

The case or shell of the larva, Fig. 15, is not at first coiled, but slightly curved, horn-shaped, well formed at its larger end, with less solid walls at the smaller extremity. The most prominent structure in the body of the larva is an oblong mass of cells of brick red color seen through the transparent walls of the shell. In the next stage (Fig. 16) which was also found floating on the surface of the water, the shell has elongated and become partially coiled, but is still transparent and in places more or less flexible in character. The larva now occupies not more than one-half of the whole length of the case when the appendages to the head are expanded. Fig. 16 represents this larva taken on the surface of the water prior to attaching itself to some foreign object. The branchial appendages to the head are more completely developed in this than in previous conditions in the growth of Spirorbis. The ciliation upon them is also more conspicuous than in previous embryos. The operculum is represented on the right hand side of the figure.

The collar, which when the head is extended from the case, is reflexed over the edge of the shell, is clothed with minute cilia. As in previous larvæ, drawings are very difficult to make on account of the quick motion in the retraction of the head, in this the difficulties are even greater. A camera drawing of the case is, however, very easy to obtain from its more solid nature. The soft parts were taken from a specimen which was dead, but not distorted by the conservative fluids in which it was preserved,

On the body of the worm three pairs of spines, which are hook-shaped at their extremities and connected with the body walls by strong muscles, were observed. These spines are placed as in early stages upon the anterior body region, and are very prominent. The posterior body region is destitute of spines in this stage. One of the most conspicuous structures in the body of the worm is a large oblong mass, of reddish color, easily seen through the transparent walls of the case which encloses the worm. The size of the worm is 2^{mm} measured from one side of the coiled case to the opposite side.

EXPLANATION OF THE FIGURES.

cap, capsule in which the embryo is enclosed.
cs, covering in which the "strings" of ova are found.
cil, cilia.
col, collar.
eb, epiblast.
mb, mesoblast.
oc, ocellus.
op, operculum.
or, mouth.
pj, projections which later grow together and form the collar.
pr, posterior body region.
ta, tentacle.

PLATE XI.

FIG. 1.—The terminal egg of a string in its capsule after segmentation and formation of layers and cilia. Larva in capsule and chain.

(Figs. 2–4, the same embryo still in capsule older than the last.)

" 2.—Lateral view.
" 3.—From posterior pole. Larva in capsule and chain.
" 4.—From ventral side.

(Figs. 5–7, still older larva.)

" 5.—Lateral view.
" 6.—Ventral view.
" 7.—View from anterior pole.
" 8.—Lateral view of a larva slightly more mature than the last.
" 9.—Older larva from ventral surface just before escape from its capsule. Terminal larva in the chain.

FIG. 10.—Free young captured on surface of the water in glass jar containing specimens of the adult. Size 1^{mm}.

" 11.—View of the head of a young Spirorbis older than the last with the beginning of the operculum and the right hand tentacle, seen from the dorsal side.

PLATE XII.

FIG. 12.—Side view of a larva of the same age.

" 13.—The same larva older, seen from the dorsal side.

" 14.—An older larva seen from the ventral side.

" 15.—Larval Spirorbis which has just begun to secrete its shell, shown with the collar and head partly protruded.

" 16.—An older larva with shell more completely formed than in the last. The head and collar are extruded. Size 2^{mm}.

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PENNSYLVANIA BEFORE AND AFTER THE ELEVATION OF THE APPALACHIAN MOUNTAINS, A STUDY IN DYNAMICAL GEOLOGY.

BY PROFESSOR E. W. CLAYPOLE.

THE geologist traveling or working among the contorted strata of Pennsylvania can scarcely escape being struck by the immense compression which the rocks of that part of the country experienced during the folding process which was the first stage in the formation of its mountain ranges. By this term I do not mean merely the condensation of the rock-masses by the tangential pressure to which the folds are due, but the actual shortening of the surface which must have resulted from the folding.

Doubtless the thought has occurred to others, but I do not recollect seeing it put forward or developed to its legitimate conclusions. Yet it is obvious that so extensive a corrugation of the earth's crust manifesting itself by the production of several wide anticlinal arches, from which the present mountains have been carved, must have been accompanied by a diminution of the area over which those strata previously extended.

To measure as nearly as practicable the extent of this contraction of the surface and to set forth the more important conclusions deducible therefrom are the objects of this paper.[1]

To prevent undue extension in treating the subject, it will be necessary to assume certain propositions. These will be here

[1] An abstract of this paper was read before the British Association at Montreal in August, 1884.

mentioned. They are, I think, now fully accepted by all dynamical geologists.

1. That cooling and consequent shrinkage taking place in the earth's heated interior, must produce and have produced tangential pressure in the hardened and cooled crust.

2. That this tangential pressure overcoming the rigidity of the crust has produced deformation or crumpling.

3. That this crumpling of the strata was the first and leading factor in the production of mountain-ranges which have been carved by meteoric action out of the folds this produced.

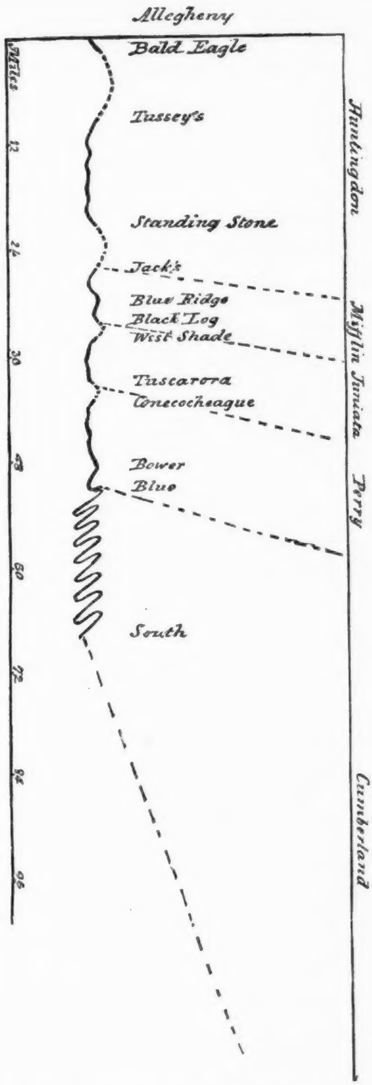
4. That the folds out of which the Appalachian mountains have been carved were formed during the later part of the Palæozoic era.

Yet further to limit the subject and bring it within the bounds of practicable treatment, another exclusion must be made. Middle Pennsylvania, from Harrisburg to Pittsburgh, is occupied by an almost continuous succession of arches of the folded Palæozoic rocks. Some of these are closely pressed, others are more open, some are long, ranging for many miles from north-east to south-west, others run only a few miles. Some involve a great breadth of country, others extend over only a few hundred yards. To take account of all these is impossible. The geography and geology of the State are not yet sufficiently known to supply the details, and the space at command is too small to discuss them if supplied. I therefore propose to omit all the less important ones and to consider only the leading mountain ranges of Appalachian Pennsylvania.

The number of these varies in different places, but not so as to seriously affect the results sought. Thirteen principal ridges traverse the middle of the State from north-east to south-west. All these may be cut by a line drawn from a point near Warrior's Mark in Huntingdon county, to another ten miles south-west of Carlisle.

These thirteen ranges are the following:

13. Allegheny mountain.	6. West Shade mountain.
12. Bald Eagle "	5. Tuscarora "
11. Tussey "	4. Conecocheague "
10. Standing Stone "	3. Bower "
9. Jacks "	2. Blue "
8. Blue Ridge.	1. South "
7. Black Log "	



Section across Middle Pennsylvania, showing amount of compression of surface.

From this list I shall exclude the first because it consists in great part of gneissic rocks whose bedding is doubtful and difficult of detection, and the thirteenth because its strata are of later date than those of the other ranges. There remain, therefore, for discussion eleven distinct mountains, rudely parallel, and, for Pennsylvania, of the first order. To prevent misconception or objection I should state that all these ranges are composed, medially, of the same rock—the massive Medina sandstone—the base of the Silurian system proper in Pennsylvania. The possible error of counting the same dip more than once is, by this fact, evaded.

The line of section above mentioned is sixty-five miles long, and may be divided naturally into two parts. One extends from its north-western end to the Blue mountains, and the other from the Blue mountains to its south-eastern end. The first division is forty-nine miles long and crosses all the eleven ranges of mountains above named. The second is sixteen miles long, and crosses only the Cumberland valley.

The line lies in six counties, among which it is distributed as follows:

Blair	2	miles.
Huntingdon	24	"
Mifflin	6	"
Juniata	8	"
Perry	9	"
Cumberland	16	"
	65	

The accompanying plan exhibits the relation of the eleven ranges to one another, and the section shews the position of the bed of Medina sandstone which forms the axis of each.

The problem is now reduced to finding the length of the line representing this bed of sandstone in its present contorted condition, for that must represent, approximately at least, its original extent when spread out flat.

Taking first its north-western portion forty-nine miles in length I have drawn it as nearly as possible to scale on the accompanying diagram. I propose now to make a deduction of twenty miles for the flattish tops of the arches and bottoms of the troughs—an allowance which is, I think, in excess of the truth. This deduction leaves twenty-nine miles of strata, dipping more or less steeply, often standing nearly vertical, sometimes over-

thrown and probably at most exposures approaching or exceeding a dip of 45°. Over this distance I propose to assume an average dip of 40°, which to me seems fairly to represent the facts and to be rather below than above the truth. A simple calculation then proves that these twenty-nine miles of strata, if flattened out, would measure about thirty-eight miles.

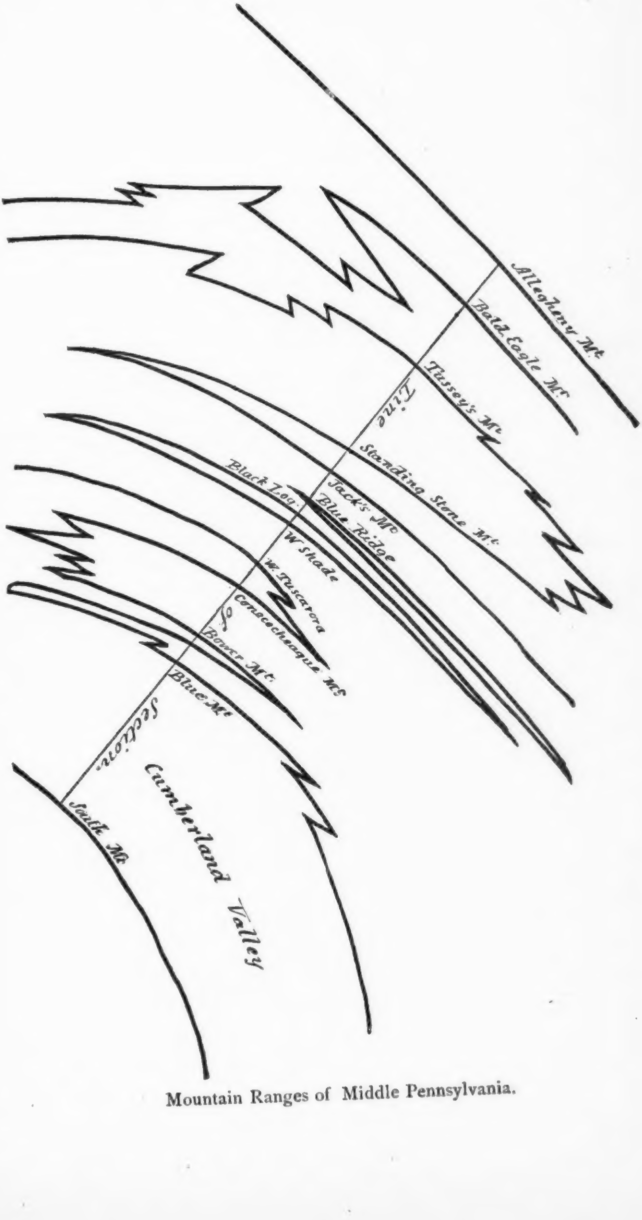
If from the accompanying section the distances representing these twenty-nine miles are taken out and measured by the scale, a result in close agreement with the above will be obtained. The two confirm each other.

In regard to the Cumberland valley the problem is more difficult. South of the Blue mountain the structure of the country is very different. Here the Medina sandstone is lost, having been entirely removed by erosion, and we are consequently compelled to adopt another stratum. The valley consists entirely of Cambro-Silurian limestone and slate dipping steeply, and the latter showing strongly developed cleavage. On the north-western sides of the arches the strata are usually inverted. It is evident at once that compression has here been much greater and the tangential compressing force much more intense than along the other portion of the line. Professor Rogers says in the Geological Survey of Pennsylvania (Vol. 1, p. 240):

"The dip of the south-eastern leg of the arch is from 45° to 60°, while that of the north-western inverted side is from 60° to 80°." "The formations repeat themselves in several narrow, short and parallel anticlinal and synclinal outcrops. They are folded into a very uniform steep south-eastern dip in a series of compressed flexures, readily discernible on the Cumberland Valley Railroad. Along the south-eastern margin of the valley so general is the inversion of the folded limestone that this formation appears everywhere to dip under the primal rocks of the South mountains, and had we not fully established their true position we might imagine the former to be the lower or older group" (p. 1113).

Adopting Professor Rogers's figures, it is clear that the results obtainable from the Cumberland valley must far exceed in proportion those above given from the counties lying farther to the north-west. The dips above stated show that the inverted sides of the arches altogether underlie the others, and the measurements obtained for them must therefore be added to those found for the south-eastern or uninverted sides. The latter will be first considered.

PLATE XIV.



Mountain Ranges of Middle Pennsylvania.

Miami University.

In consequence of the condition of the strata it is exceedingly difficult to determine in the field the number of folds occurring in the valley. It is not probable, moreover, that they are regular or constant. The beds involved are, however, about a mile in thickness, so that there can scarcely be less than eight arches in the sixteen miles. If then for the south-eastern legs we adopt Professor Rogers's lowest angle of dip, or 45°, and for the north-western sides his lowest estimate, or 60°, and plat these to scale, we have the following result:

The Cumberland valley, sixteen miles wide, consists of at least eight overthrown anticlinal arches, the crest of each of which overlaps to some extent the base of that following it. This will be clear from an inspection of the diagram, where a single bed of rock is shown folded as required by the conditions above given. *A B C*, &c., are the successive crests of the arches formed by the stratum. *X Y* represents the present surface of the ground. *a b c* are the bases of the synclines corresponding to the arches. Taking into consideration the mid-layer of the stratum represented by *Q O S T U V*, &c., which will represent the actual length of the folded bed, a short mathematical calculation will prove that *O Q* is 3.3 times as long as *R Q*. *R Q* representing one mile, *O N* will therefore represent 6.6 miles. All the eight south-eastern legs of the arches will consequently measure about fifty-two miles.

In like manner we find that the length of the line *O R*, compared with *R Q*, is 2.7. Consequently the length of the line *O S* represents 5.4 miles and the eight north-western sides of the arches amount to forty-three miles.

Again, a reference to the figure will show that the north-western side of each arch underlies its south-eastern side, so that its whole length must be added to the figures previously obtained.

Summing up results, we find:

Twenty-nine miles at 40° dip, or	38	miles.
Eight anticlinal arches in Cumberland valley—		
South-eastern sides	52	"
North-western sides	43	"
Add twenty miles for flat strata, as previously deducted	20	"
Total	153	"

In other terms this means that a tract of the earth's surface measuring originally 153 miles from south-east to north-west has

been so crushed and compressed that its present breadth along the line of section is only sixty-five miles. Of this shortening the greater part has been suffered by the Cumberland valley, where ninety-five miles of country have been compressed into sixteen miles.

The diagram shows the distribution of the compression among the different counties. Approximately it may be represented by the following figures:

ORIGINAL AND PRESENT EXTENT OF THE COUNTIES ALONG THE LINE OF SECTION.

	Original extent.	Present extent.
Blair	2 miles.	2 miles.
Huntingdon	26 "	24 "
Mifflin	8 "	6 "
Juniata	10 "	8 "
Perry	12 "	9 "
	58	49
Cumberland	95 "	16 "
	153 "	65 "

These facts may be thus expressed. During the compression and corrugation of the crust to which the mountains of Pennsylvania owe their origin, the south-east line of Huntingdon county was moved forward two miles, that of Mifflin four miles, that of Juniata six miles, that of Perry nine miles and that of Cumberland eighty-eight miles. Consequently the whole of Mifflin county was shoved, at the least, two miles to the north-west, the whole of Juniata county four miles, the whole of Perry county six miles and the whole of Cumberland county nine miles over the underlying deeper strata. The possibility, still less the reality, of mass-motion of this kind and to this extent, has not, it seems to me, been generally recognized by geologists.

The movement of course diminished toward the north-west in consequence of the increasing resistance offered by the increasing load, and came at length to nothing beyond the limits of Pennsylvania. Ohio was the great buffer-plate against which this tremendous earth-force spent itself. The south-eastern portion of the district—the Cumberland valley—and even probably some considerable area beyond it to the south-east felt its first and mightiest pressure. There the strata were crumpled, bent, crushed and thereby thickened until it became easier to shove them bodily forward than to bend them again. They were consequently added

PLATE XV.

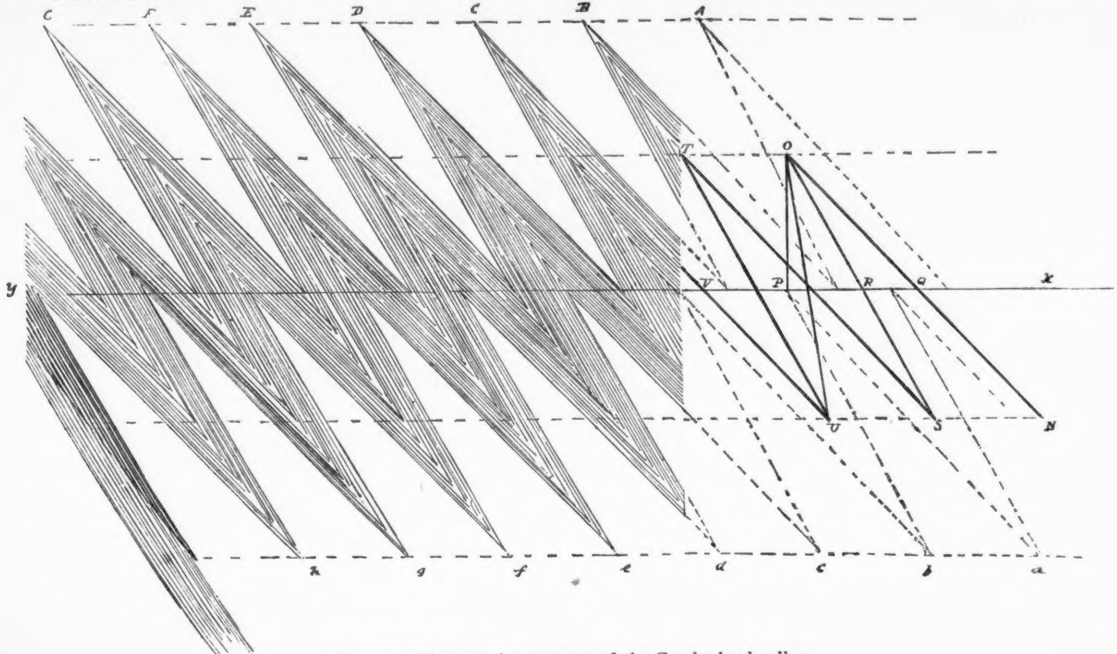


Diagram to illustrate the structure of the Cumberland valley.

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as a snow-plough in front of the mighty engine, and in their turn communicated the movement and the crumpling to the north-western country beyond them.

It is possible that considerable correction might be made in these figures if more accurate details of structure were attainable. This correction might be in either direction. That it would not all tend to diminish the result seems clear from the following considerations:

(1) No account is taken of the condensation of the strata during compression.

(2) The line of section does not pass through the most distorted district.

(3) All effects of compression in and beyond the South mountain and west of the Bald Eagle range are disregarded.

(4) The summits of the arches and the bottoms of the troughs are assumed to be, but are not quite flat.

(5) No account is taken of numerous intermediate minor folds or of several faults, at some of which the older strata to the south-east have been shoved *uphill* over the edge of the newer north-western beds at an angle which observation does not yet enable us to determine.

On the other hand the height of the creases in the Cumberland valley may be somewhat less than that shown in the diagram and assumed in the calculation. All these minor considerations cannot affect the main point at issue. The figures above given indicate a compression of the superficial layer of the crust in Pennsylvania during the process of crumpling by which eighty-eight miles of the surface have disappeared, sixty-five miles at present being all that remain from a former breadth of 153 miles. Even if only one-half of these figures be taken into account, the problem remains equally difficult. How can such a shortening of the surface be accounted for?

We are at no loss for a force competent to produce it. The tangential pressure developed by a contracting nucleus under a solid crust is amply sufficient to deform and corrugate that crust. But to realize the effect which this tangential pressure has produced is less easy.

A shortening of the circumference by eighty-eight miles is equivalent to a shortening of the diameter of the earth by about twenty-seven miles. Are we prepared to admit that the globe

actually contracted to that extent during the formation of the Appalachian earth-folds? If not, how shall the facts above stated be explained?

The suggestion has been made that the subsidence of the present bed of the Atlantic from a continental level in late Palæozoic days may have supplied the necessary compressing force and have produced the shortening here pointed out. But the cause is totally inadequate. Supposing that the whole Atlantic area had subsided from the mean height of one mile above sea-level to five miles below it at its middle or deepest point—a maximum supposition—then a short calculation will prove that the new and flattened arc so produced, of 60° in extent, would measure only about three miles less than the previously existing one. This amount, if wholly expended in crushing the thick Appalachian sediments, would evidently be far from sufficient for the solution of our problem.

Without therefore denying the occurrence of such a subsidence, we can lay it out of the case as inadequate.

Is it possible to believe that there was an accumulation of strain on the crust during preceding ages, which was relieved by the occurrence of this paroxysmal compression and corrugation. Such a supposition would meet with strong opponents in many quarters.

Mathematicians tell us that the crust cannot endure the strain which would be caused by the shrinking away of the nucleus in consequence of contraction, but must close down at once upon the latter as it sinks. Some of them add that this would be the case were it many times as resistent as now. If so, any such accumulation of strain is evidently impossible.

But there is a possibility that the interior of the earth may be of such a nature as to allow of some considerable amount of shrinkage without leaving the crust completely unsupported. This partial support might enable contraction to proceed for some time before the closure of the crust upon the shrinking nucleus followed. A cellular structure about the place of junction between the cool and heated portion might render possible such a condition of things. Our ignorance of the earth's interior is at present so dense that any supposition which does not clash with well established facts is admissible for the purpose of argument.[1]

[1] In this connection I may remark that since writing the above passage I find that

The mathematical solution of geological problems such as that now under consideration is far from being satisfactory to geologists. Without in the least undervaluing the labors of the many eminent mathematicians who have taken the subject in hand, I may plainly assert that the conditions are yet too little known to enable them to apply their processes with complete success. The mill grinds out its meal according to the nature of the grist supplied, but cannot change its quality. So the mathematical engine, of whatever kind, works out its conclusions from the premises given. If these are full and true the results cannot be false. But if these are insufficient and half unknown, or if any of them are much limited and modified, the results are to an uncertain extent invalidated. This is the case with almost all investigations dealing with the condition of the earth's interior. In order to bring them within the grasp of mathematical formulas the data of the problem are narrowed down or altered to so great a degree that the conclusion, though true for these, is false for the actual data. A logical fallacy lurks in the argument. The reasoning deals with an imaginary earth possessing certain comparatively simple characters. The conclusion when obtained is applied to the real earth, whose characters are much more complicated. The confusion lies in the employment of the term "earth" in two different senses—a logical fallacy of the first magnitude, and one whose insinuation into any geological problem must be avoided with the utmost care if conclusions of value are anticipated.

Hence without any expressed or implied disrespect to the mathematician, the geologist may receive his arguments on geo-

Dr. T. Sterry Hunt has recently, in the discussion of a different subject, put forward some views which deserve mention in this connection, and may not be without bearing upon the matter in hand. He has dwelt strongly on the universally crumpled condition of the metamorphic rocks, and has suggested that in the early days, when these strata were deposited, enormous quantities of matter were removed by the action of springs from the interior to the outside of the earth. This removal must have left cavities below, into which the crust sank, and in sinking became thus universally corrugated. This he calls the *crenitic* theory of metamorphism. It is obvious that Dr. Hunt's suggestion is in line with that above made, though the phenomena to be explained are much earlier in date and consequently in a more obscure and debatable region. Much less is known of the date and mode of formation of ranges of metamorphic strata than of the Appalachian mountains. What is supposable at one stage need not, however, be absurd at another, and I am glad to be able to quote Dr. Hunt's words, even if only in a slight degree conveying a suggestion similar to my own.

logical problems with great reserve. While he welcomes all aid from this quarter for his difficult tasks, he should not allow a mathematical deduction of the kind above mentioned to prevent his acceptance of a contradictory physical deduction from observed facts. If the latter warrant any inference out of harmony with the former, there is at least a possibility that the latter may be right. And in our discussions regarding the interior of the earth we are in this condition. The data of the problem are as yet too obscure and uncertain for the mathematical engine, and physical deductions from observation claim and deserve at least equal consideration.

If then the facts here detailed justify the interpretation put upon them, they lead to conclusions which, if admitted by a few geologists, have certainly not been generally asserted. If these indications of contraction are acknowledged to the full extent here given, or even to any considerable portion of that extent, they require admissions and lead to conclusions for which all are not prepared, and to which not a few will be strongly opposed. If the eastern seaboard of North America has, by tangential pressure, been shortened so that a line originally 153 miles long now measures only sixty-five miles, the circumference of the earth must be lessened to that extent. Consequently the admission of the statement here made involves an admission that the diameter of the earth was diminished by about one-third of this amount, or that its radius was shortened thirteen miles by contraction during the later part of the Palæozoic era. Geology is not fully prepared for this conclusion, and astronomy is perhaps less ready for it. Yet, unless one or the other can find some better explanation, the unwillingness to admit is not a sufficient reason for rejecting it.

It is not the object of this paper to consider and discuss the various objections that must arise to the conclusion above stated. And such discussion would require more space than can be here occupied. A few words in conclusion must suffice.

Possibly, though in treading on so uncertain a ground and in so dim a light I wish to advance with the greatest caution, aware that every step may be in the wrong direction, yet possibly there are indications to be found elsewhere which may render the inference above drawn a little less startling, even if they do not bring it within the bounds of ready credibility. Spasmodic action with

intervals of repose is a usual mode of operation in nature. Without going back to earlier days, whose events are more obscure, I will consider only the later geological history of our globe. And here are not wanting evidences of similar changes. Admitting that cooling and consequent internal contraction have been, by physical necessity, continuous, there seem to be indications that the subsequent corrugation of the crust has been to some extent spasmodic. Beyond doubt the formation of arches and troughs by compression of the strata has occurred in almost every era. Perhaps when we know the whole earth we may find no time of perfect repose. But since the Palæozoic era ended there has been at least one period during which the process again rose into great prominence, eclipsing perhaps that which it exhibited in Palæozoic days. Anticlinal arches can be found of almost every date in Secondary time. But after the beginning of the Tertiary age, and through a great part of its duration, their development became wonderful. Almost all the great mountain ranges date from this era. Strip from the earth the mountains of Tertiary date and it would lose nearly all its grandest features, and would be reduced to a comparatively monotonous plain. The Rocky mountains and the Andes in the western world, and in the east the Alps, the Apennines, the Pyrenees, the Carpathians and the Himalayas, with other minor chains, all date back to about Mid-tertiary days. And the elevation of so many lofty anticlinal folds, in comparatively a short time, threw into the shade all events of the kind that had occurred since the great Appalachian revolution. It is not yet possible to estimate, still less to measure, the folds of these ranges, but it impossible to doubt that they would yield results scarcely less, and perhaps greater, than those which I have given for Pennsylvania.

What then must be our conclusion ? Must we incline to the belief that our earth has much diminished in size since the middle of Palæozoic time ? Must we admit that this diminution amounts to many miles ? That the radius is thirteen miles shorter than it then was, and the circumference less by six times that amount ? Apparently there is no escape.

One word more. Is not the admission reasonable ? Is not the denial unreasonable ? If the earth is a cooling and contracting globe the result must surely be evident in the long ages that have elapsed since the Appalachian earth-folds arose. If the corru-

gation due to contraction in that interval is inappreciable, what an enormous time must be allotted to the earlier stages of geological history! Even allowing for a greater rate of cooling in those earlier days, the time will surpass all that geologists have demanded, and be more difficult of admission than the contraction here contended for. It is not easy to admit that cooling, contraction and crumpling have been important factors in the formation of the surface of our globe, and at the same time to deny that their action has been perceptible or important since Mid-palæozoic ages, that is during a lapse of time amounting probably to not less than fifteen millions of years.

Further, it is not impossible or improbable that the facts and inferences here detailed may be useful in the solution of some difficult geological problems, especially regarding the older rocks. If mass-motion to so great an extent has taken place in the earth's crust since Palæozoic time began—if the tangential thrust has produced lateral movements in the rocks such as those here described and others which might have been mentioned—if strata have slid bodily over strata for great distances, and whole counties have been shoved for miles out of their previous places, it is obvious that enormous lateral displacement of strata must be recognized as a momentous factor in geology, and that older beds may be found far out of their expected places and even overlying newer ones. Into this subject, however, I cannot now enter, but leave it with the single remark that the greatest caution and reserve must be manifested and every element of doubt eliminated before we can confidently assert that in regions of disturbance the *upper* is the *later* deposit.

I may be allowed to repeat in conclusion that the inferences here deduced do not rest on exact accuracy in the figures employed. Were they considerably in excess of the truth the argument would still hold good. Even the half of the amount of contraction involved would far surpass what geologists have been in the habit of claiming or astronomers of allowing.

LIFE AND NATURE IN SOUTHERN LABRADOR.

BY A. S. PACKARD.

THE following recollections of our student days are offered with the suggestion that our college boys of the present day might spend to advantage the long summer vacation in cruising on our northern coasts, and combine in agreeable proportions science and travel.

In the summer of 1860, while a student in Bowdoin College, I joined the Williams College expedition to Labrador and Greenland under the charge of Professor P. A. Chadbourne. June 27th found us on board the *Nautilus*, a staunch schooner of about 140 tons, commanded by Capt. Randlett. Soon after five o'clock of a bright fresh morning our vessel cast off from the wharf at Thomaston, Me. The Thomaston band played a lively air, a clergyman made a parting address, calling down the blessings of heaven upon the argonauts; our Nestor replied, the students cheering for the citizens of Thomaston and the band, and with a favoring north-west wind the *Nautilus*, gliding down the current of the St. George's river, a deep fiord, in a couple of hours reached the open sea.

Our course lay inside of Monhegan, with its high, bold sea wall. Passing on, the Camden hills recede, and we endeavor with the glass to make out the White mountains, said by some to have been seen by Weymouth from inside of Monhegan. The ocean swell not being conducive to historical controversy, we turn to watch the Mother Carey's chickens and the grampus as well as the fin-back whales sporting in the waves.

By the next morning we had sailed 190 miles from Thomaston, past Cape Sable, and our north-west wind still attending, we bowl along, through schools of porpoise, while two or three whales pass within a few fathoms of our vessel, showing their huge whitish backs. The next day our seven-knot breeze does not fail us, and takes us by the 30th into a region of light winds and calms off the Gut of Canso.

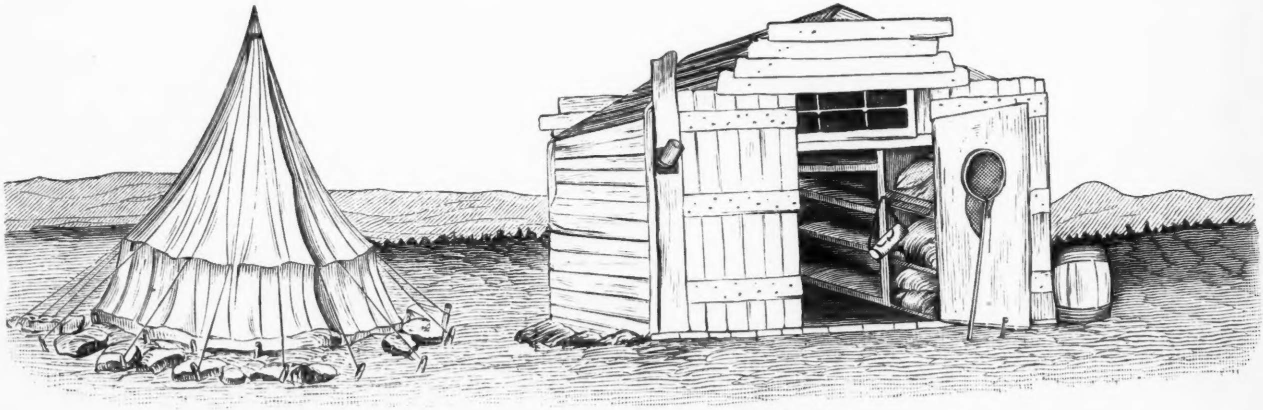
July 1st we sail along Cape Breton island, its red shores glistening in the noon-day sun and then mantled with purple as the sun goes down over Louisbourg. As darkness sets in the lights of Sidney appear. The next morning's sun rose on Cape Ray, around which we beat, passing within a mile of Channels, a fish-

ing village of Newfoundland, behind which rise steep hills clothed with "tucking-bush," or dwarf spruce and larch. Cape Ray pushes boldly into the sea, its precipitous sides of decomposed sandstone furrowed by the rains which pour down its scarred cheeks, on which still linger banks of the last winter's snows.

By the next evening we pass Cape St. Georges. The 4th was celebrated in the Gulf of St. Lawrence amid fog and rain. It was succeeded by a twenty-four hours' gale, rather severe for the season, which tested the excellent qualities of the *Nautilus* as a sea boat. This being our first storm at sea was enjoyed more keenly than similar gales in after years. The sea swept our deck, but only a few drops entered the cabin. The experience was novel and interesting, fortunately we were not sea sick; the long waves sloped up like far-reaching hills; sea birds rode on their crests, and the wind, like a swarm of furies, tore through our rigging. There were but occasional glimpses from the companion way of our dark, close cabin, redolent with the stench of the bilge water. The storm abated after sunset, and the morning of the 6th found us only fifty miles from Caribou island. Toward noon the first iceberg was seen; others came into view, some stranded, others floating on the sea.

The evening was a glorious one; after a gorgeous sunset, the twilight lasting until after ten o'clock, the moon rose upon berg and sea. We were in an arctic ocean; creatures born in the Greenland seas floated past our vessel, and while becalmed at night we fish up from a depth of sixty or seventy fathoms a basket starfish (*Astrophyton agassizii*) large enough to cover the bottom of a pail.

The impressions made on our minds the next day as we approached the coast and passed in shore, winding through the labyrinth of islands fringing the main land, are ineffaceable. That and other days in Southern Labrador are stamped indelibly on our mind. It was passing from the temperate zone into the life and nature of the arctic regions. There is a strange commingling of life-forms in the Straits of Belle Isle. The flora and fauna of the boreal regions struggling, as it were, to displace the arctic forms established on these shores since the ice period, when Labrador was mantled in perennial snow and ice, when the great auk, the walrus and the narwhal abounded in the waters of the Gulf of St. Lawrence, and the Greenland flora, represented by



The Naturalists' Camp on "the Labrador."

the *Arenaria grœnlandica*, the dwarf cranberry, and the curlew berry or black Empetrum, nestled among the snow and ice of the glacier-ridden hills.

We landed on the morning of July 7th, and I was astonished at the richness of the arctic flora which carpeted the more level portions of the island. Groves of dwarfed alders, over which one could look while sitting down, crowded the sides of the valleys, watered by rills of pure ice-cold water. The groves of spruce and hackmatack were of the same lilliputian height. In the glades of these dwarfed forests, and scattered over the moss-covered rocks and bogs were *Cornus canadensis*, two varieties in flower; *Kalmia glauca* was in profusion, as attractive a flower as any; the curlew berry (*Empetrum nigrum*), the dwarf cranberry, with other flowers and grasses characteristic of the arctic and Alpine regions. Particularly noticeable were the clumps of dwarf willow from six inches to a foot in height, now in flower and visited by the arctic humble bee and other wild bees. Other insects of subarctic and arctic types were numerous, among them a geometrid moth (*Rheumaptera hastata*), which extends from the Alps and snow fields of Lapland around through Greenland and Labrador to the mountain regions of Maine, New Hampshire and Northern New York. The flies, beetles and other forms had an arctic aspect, showing that on the shores of the Straits of Belle Isle the insect fauna is largely tinged with circumpolar forms.

On the 7th of July our party of seven men landed, lodged in a Sibley tent, and the *Nautilus* left us for the Greenland seas with the majority of our party. Our tent, provisions and baggage becoming soaked with the rain and dampness; two days after, we moved over to Caribou island and built a house of Canada clapboards, kindly loaned for the purpose by the Rev. C. C. Carpenter, missionary to Southern Labrador, for whom a large frame house, sheltering under its roof a chapel, study and living rooms was building.

A Canadian clapboard is twelve inches long and six inches wide; with these and a few joists two of the party built a house twelve feet square, which sheltered us from the sun and the black flies, and only leaked when it stormed, which happened regularly twice a week, usually Wednesdays and Sundays. Six berths were put up on the north side (the seventh man was accommodated in the mission house); a wide board placed on two flour barrels at

the west end served as a dining and study table, and in the south-east corner a little stove, not over fifteen inches square, with a funnel whose elbow, projecting out-of-doors, had to be turned with every change of wind, was the *focus*, the modernized hearth-stone, over which hung our Lares and Penates, sundry hams and pieces of dried beef, *pièces-de-resistance* of our meals, often alleviated by game and fish, clams and scollops or pussels (*Pecten magellanicus*), with oases of seal and whale flesh. How we college boys cooked and ate, rambled and slept in those seven weeks of sub-arctic life is a subject of pleasant memory. They were days of rare pleasure, of continuous health, and formed an experience whose value lasted through our future lives. We made hunting, ornithological, entomological, botanical and dredging expeditions in all directions, by sea and land; the geology, and the flora and fauna were explored with zeal, and resulted in the discovery of many new forms and the detection of Alpine and arctic European species before unknown to this continent. We investigated the Quaternary formation, ice marks, drift and fossil shells; procured fossils of the Cambrian red sandstone beds, chiefly a sponge (a new species of Archæocyathus), which were scattered along the shore, probably derived from the red sandstone strata so well developed at Bradore, also visited by some of our party. The results were perhaps of some importance to science, and the lessons in natural science we learned of far greater moment to ourselves.

The coast of Labrador is fringed with islands, large and small, from the mouth of the St. Lawrence to Hudson's strait. A sail-boat can go with safety from one point to the other, and only occasionally will be exposed to the ocean swell. These islands are the exact counterpart of each other, differing mainly only in size and altitude. Caribou island was two or three miles in length, formed of Laurentian gneiss, which had been worn and molded by glaciers. Its scenic features recalled those of the more rugged portions of the coast of Maine, particularly in Penobscot bay and Mt. Desert. The higher portions of the island is of bare rounded rock, with deep valleys or fissures down which run little rills; these valleys are dense with ferns, shelter many insects, and where they widen out into the lower land support a growth of dwarf spruce, hackmatack and willow. In the more protected parts a few poplars and mountain ash rise to a height of from ten to fifteen feet. The Alpine vegetation is mostly confined to the ex-

posed boggy places or moors, in which are pools of water, supporting water boatmen, case worms, aquatic beetles and numerous water fleas, and an occasional hair worm or Gordius.

Along the lower portions by the shores are patches of salt marsh with shallow pools of water, which in the spring and autumn are undoubtedly frequented by ducks and geese, though only a few of the former were to be seen. Indeed, I was surprised to see so few sea-fowl. They were principally the parroquet, which abounded on the sea a mile or two away from shore. A favorite breeding place of this most interesting of arctic birds was in the soft red Cambrian sandstone of Bradore, an island lying fifteen miles easterly from Caribou island. With their powerful parrot-like beaks they excavate the crumbling rock, extending their galleries in to the distance of several feet. Three of our party made an expedition to this well-known breeding resort, and in thrusting their hands into the burrows received an occasional bite from the sharp strong bills of the birds, which was nòt soon forgotten. Ducks were occasionally seen, the eider duck and also the coot, as well as the loon, both the northern diver and the red-necked loon. Shore birds, particularly the ring-necked plover, and others of its family, abounded, while the most familiar bird was a white-headed sparrow which nested near our camp.

It was not yet the time for the curlews. About the middle of July the shelldrake and coot, which breed in the inland ponds, lead out their young and appear in great numbers. The old ones are wary and hard to shoot, but the young will then be in fine condition. At this time the "long-shore-men" abandon their diet of salt pork, bread and molasses, and feast on game, for then we were assured they have "great plenty fowl."

In August, also, one or two families of the red Indians or mountaineers of the interior come down to the mouth of the Esquimaux, or "Hawskimaw" river, as it is pronounced by the settlers, to hunt seal, especially the young, and ducks as well as curlew. These Indians are entirely governed in their wandering by the situation of the deer and other game. One may travel a hundred miles up the Esquimaux river without meeting them.

I saw but a single Esquimaux man at Caribou island. His low stature, his prominent, angular cheek bones, pentagonal face and straight black hair sufficiently characterized his stock. The only other native Esquimaux was the wife of an Englishman,

John Goddard, the "King of Labrador," who lived on a point of land three miles west of Caribou island. She was a famous hunter, would go out in a boat, shoot a seal and dress it, making boots and moccasins from the skin. Whether these Esquimaux had strayed down from the north or, as I suspect, were the remnants of their people who may have inhabited the entire coast from the Gulf of St. Lawrence to the arctic regions, deserves further investigation.

Few mammals were to be seen. The deer and caribou were confined to the mainland. On our island was a white fox, or rather a blue one, for his summer pelage was of a slate color. His burrow was situated in a hill side behind our house. He would prowl about our camp at night, and he might have known that it was unsafe to come within reach of our guns. His skin undoubtedly adorns the museum of the Lyceum of Natural History of Williams College.

A weazel also visited our camp. The otter frequents the brooks at the head of Salmon and Esquimaux rivers. In winter they rarely come outside, *i. e.*, to the coast.

It is well known that in Newfoundland the bears, especially those living near shore, will eat fish, their diet being mixed, and such bears are more savage than those in the interior which live chiefly on berries and ants. While on Caribou island a fisherman living a mile and a half from us had his sea-trout nets invaded by two old bears accompanied by a young one; at low water they would walk out to the nets, tearing them apart in order to eat the fish.

Speaking of trout, there are two kinds; one living in the brooks and lakes, the other the sea trout, a handsome fish about twelve inches in length, whose food we found consisted of a surface-swimming marine shrimp, the *Mysis oculata*, which lives in immense shoals. The sea trout is taken in nets, and so far as we experimented do not, in salt water, rise to the fly.

Although it was now the 15th of July the warmer summer weather had not yet come, we were told by the people on shore. There is, however, scarcely any spring in Labrador. The rivers open and the snow disappears by the 10th of June as a rule, and then the short summer is at once ushered in.

Potatoes and especially turnips are raised without much difficulty as far north as Caribou island. Rhubarb is said to do well farther up the coast towards the Mecatina islands. Among the

wild flowers blooming in the middle of July were the dandelion and *Potentilla anserina*. Another Potentilla was the *P. tridentata*, the mountain trident, with its three-toothed leaf and modest white flower. It was pleasant to see this flower, so familiar from my earliest childhood, as it flourishes on the plains of Brunswick, Me., and is common on Mt. Washington as well as on the mountains of Maine, and abounds on the bare spots about Moosehead lake, particularly at the foot of Mt. Kineo. The wild currant, strawberry and raspberry were in flower; the strawberry plants were luxuriant, sometimes eight inches in height, but the raspberries were dwarfed, not exceeding the strawberry in height. Up the rivers the raspberries and blackberries are abundant, but the latter low and dwarfish.

The shad bush (*Amelanchier canadensis*) was now in flower, blossoming in Southern New England in April or early May, while *Rubus chamæmorus*, the cloud berry, so abundant in Greenland and Arctic America as well as on the fields of Norway and Sweden and the "tundras" of Siberia, was going out of flower. With it were associated the star-flower, *Trientalis americana*, a few *Clintonia borealis*, *Smilacina bifoliata* and probably *S. stellata*, *Streptopus amplexifolia;* one or two species of Andromeda; an Iris, species of Vaccinium, the *Arctostaphylus uva-ursi* or bear berry; the shore pea, a honeysuckle (*Lonicera cærulea*), a Viburnum, and also the buckbean (*Menyanthes trifoliata*).

Among the flowers fluttered the white butterfly (*Pieris frigida*), a *Colias labradorensis*, *Argynnis triclaris* and some geometrid moths, while a few owlet moths flew out of the grass at the late twilight, which now lasted until near eleven o'clock at night, when fine print could be read.

We were told that the average temperature in June here is 48°, that of July 56°. In the warmer days of summer the thermometer rises from 64° to 68°, rarely to 70°. July 17th was one of the warmest and most pleasant days of the month; the temperature was 60° F. The 21st, however, was much warmer, the thermometer being 72° F.

July 18th was the day of the eclipse; the sun was obscured in the forenoon; the light of day was much modified, though not approaching twilight. The steamer which we saw on the day of the storm in the Gulf of St. Lawrence was without doubt that which bore the Coast Survey eclipse party to Cape Chidleigh, where the eclipse was total.

(*To be continued.*)

EDITORS' TABLE.

EDITORS: A. S. PACKARD AND E. D. COPE.

—— The appropriation of money for scientific purposes by the Congress of the United States is a just source of national pride, as it is a means of national development and prosperity. The scientific men who have the disbursement of this money hold a trust for science, and their use of it is watched by the scientific men of all countries with interest. The expenditures have been, as it appears to us, generally well directed. One of our national establishments, however, seems to us to be in danger of absolute perversion from scientific uses and purposes, though, perhaps, intelligent attention directed to the situation may be the means of arresting such a misfortune. We refer to the National Museum at Washington. By its present organization it contemplates an exhibition of the products of the United States, both raw and manufactured. At the same time it does not embrace the agencies necessary for the prosecution of scientific research, either by making collections or supporting investigators. These latter objects are within the plan which the director, Professor Baird, hopes to see realized in the future, and it is earnestly to be desired that he may be able to accomplish so important a project. We must confess, however, to a sense of disappointment in learning that this was not the original basis on which the institution was created. It might, indeed, amount to this practically, were it not that manufactured products are included in the objects to be displayed in its halls; but the introduction of this item so overbalances the scales as to leave the future of scientific collections precarious, to say the least of it. We do not see how it is possible to avoid the crowding of the building with a kind of material which has no place in a scientific museum, and which can easily occupy all the space and consume all the money which Congress can grant it. The paternity of the project for a national museum was altogether scientific, and unless this object continues predominant, it is likely to divert the lives of a certain number of scientific men from their true channels, unless they abandon it altogether. For aught that we know, the situation may be past remedy, and the scientific element may already read the "handwriting on the wall." But we hope not. The most effective remedy would be to limit the exhibition of

manufactured products of the world to those which preceded the iron age of human industry. By cutting off everything that belongs to the industrial history of the iron age, pure science will save a great amount of money and a great deal of invaluable space.—*C.*

—— The year 1884 will be notable from the important discoveries in vertebrate biology and invertebrate palæontology. It had been suspected and even stated that two mammals, the duckbill and Echidna, laid eggs; but for the first time, late in the last year, was full and convincing proof afforded by two independent observers of the fact that both of these monotremes lay large eggs, with a soft parchment-like shell, which are placed in the mammary pouch, where they incubate until the young are hatched in a partially developed state.

Late in the year also came the announcement that Dr. Lindström had discovered a fossil scorpion in the upper Silurian (Ludlow) of the island of Gotland. The presence of the stigmata, proves that it breathed air directly and was a true land animal. The publication of this important news brought to light the fact that a fossil scorpion of the same genus had previously been obtained by Dr. Hunter from the upper Ludlow beds of Lanarkshire, Scotland. This two-fold discovery carries the existence of Arachnids from the Carboniferous to the upper Silurian horizon.

Still nearer the close of the year, at the last meeting in 1884 of the French Academy, M. Charles Brongniart announced the discovery in the middle Silurian of Calvados of an insect's wing referred to a cockroach. This transfers the first appearance of insect life from the upper Devonian to the middle Silurian.

On the other hand the discovery of trilobites in the Australian Cretaceous beds was announced last year in the *Geological Magazine*; so that this type of Arthropod life is carried up from the Carboniferous to the chalk period. It will be remembered that fossil vertebrates in beds near the base of the upper Silurian of this country were reported in this magazine during last autumn by Prof. E. W. Claypole. Thus the geological record is in a single year profoundly changed, and no one can foretell what discoveries may be made in the immediate future.

——The Geological Survey of Canada is undergoing one of those periodical attacks which politicians of the less educated type make upon all government institutions which they do not understand or appreciate. As usual, they do not perceive the necessity of understanding the principles of the geological structure of the country before satisfactory "practical" results can be obtained; but are crying for less theoretical and more "practical" geology. If they will make large appropriations to the survey

under Dr. Selwyn, they will in time get all the practical ends they are after; but they must let their able chief develop the subject in the only practicable way known to science, and which he is abundantly able to accomplish.

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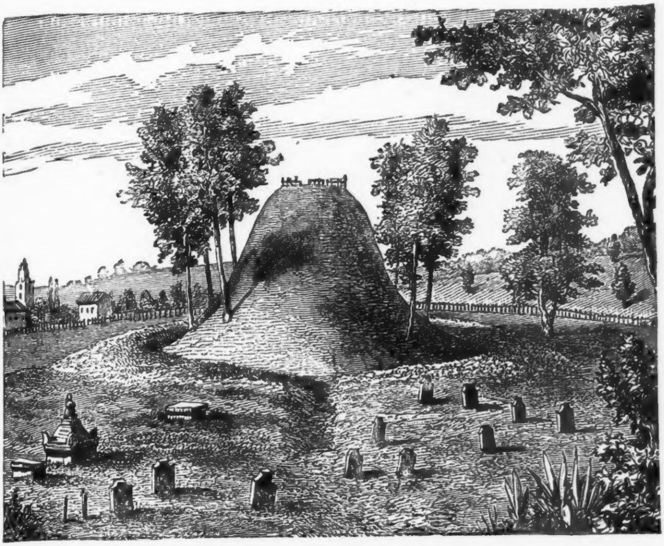
RECENT LITERATURE.

De Nadaillac's Prehistoric America.[1]—In the present state of American archæology a general work on prehistoric America would be perhaps regarded as premature, or at least as a temporary makeshift. The French author, however, has had the courage to venture on the attempt to depict the pre-Columbian history of both Americas, covering the whole field of American anthropology. His work appeared in 1882. The present work is based on a translation of De Nadaillac's work. The original contained a good many unreliable conclusions, mixed with valuable or well ascertained facts, there being on the whole little discrimination whatever in the material used. In its present shape, however, having passed through the editorial hands of Mr. W. H. Dall, who has added some new material, we do not see but that it forms an excellent and, in the main, reliable account of American primitive times. There is a popular demand for such a work; its style is light and clear, perhaps not always so sober and circumstantial as we could wish, but on the whole the book in its American dress is timely. The chapter on the origin of man in America is almost wholly Mr. Dall's, who has only retained some references to Central American and Peruvian myths from the original. As it stands, therefore, the book may be considered as a fairly good résumé of the better known facts of American archæology from a more or less European standpoint. The chapters are headed as follows: man and the mastodon; the kitchen-middens and the caves; the mound-builders; pottery, weapons and ornaments of the mound-builders; the cliff-dwellers and the inhabitants of the pueblos; the people of Central America; Peru; the men of America, and the origin of man in America.

The views concerning the Toltecs and their successors, the Aztecs, and their monuments are moderate. Montezuma's so-called "empire" was apparently little more than a confederation of tribes. Their buildings are but a few centuries old; their civilization of spontaneous growth, and very recent compared with those of the old world. As to the connection between the Central American nations and the mound-builders, this book is conservative, not conceding any such intimate relation. So far good,

[1] *Prehistoric America.* By the Marquis de Nadaillac. Translated by N. D'Anvers. Edited by W. H. Dall. With 219 illustrations. New York and London, S. P. Putnam's Sons, 1884. 8vo, pp. 566. $4.

but when the French author says that primeval man in America had to contend with elephants and edentate animals, and that the period in which he lived "was marked by floods, of which man still retains traditions;" when he proceeds to cover a large area of California with glaciers, and adopts without reservation Agassiz's view that Brazil was once covered with glaciers, we wish for a soberer, more critical narrator of events. Again the Trenton unpolished stone implements occur in the higher river terraces, which were formed long after the ice had melted and disappeared; they do not occur in true glacial deposits. Yet Nadaillac thus declaims in reference to the Trenton finds: "Man



Truncated Mound at Marietta, Ohio.

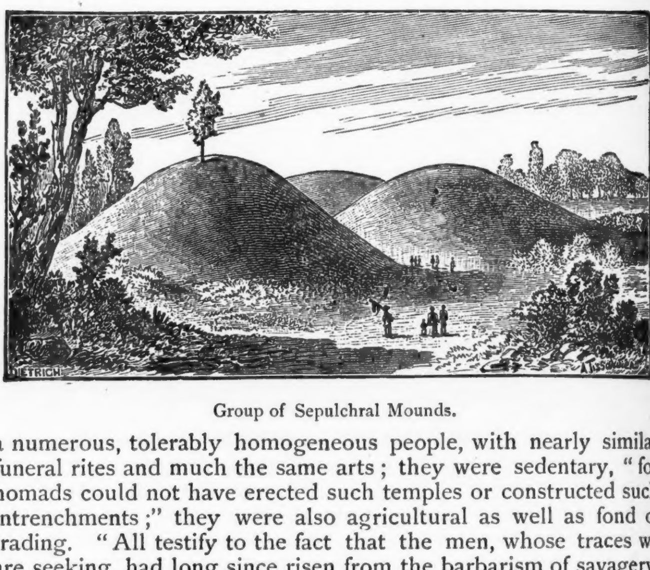
lived through these convulsions; he survived the rigors of the cold; he survived the floods, as the recent discoveries of Dr. Abbott in the glacial deposits of the Delaware near Trenton, N. J., seem to prove beyond a doubt."

Is our author not mistaken in saying that the Calaveras skull "resembles the Eskimo type;" was not Wyman's opinion that it resembled that of a California Indian the more natural and correct one?

Regarding the mound-builders, the sensible view is expressed that they were no more nor less than the immediate predecessors in blood and culture of the Indians described by De Soto's chronicler and other early explorers, the Indians who inhabited

the region of the mounds at the time of their discovery by civilized men. As in the far north, the Aleuts up to the time of their discovery were, by the testimony of the shell-heaps, as well as their language, the direct successors of the early Eskimos—so in the fertile basin of the Mississippi, the Indians were the builders or the successors of the builders of the singular and varied structures just described. The pottery of the mound-builders is quite fully described and illustrated, and it is remarked that if the American pottery be "compared with that from the middens of the lake-dwellers of Switzerland, who are supposed to have reached a similar stage of civilization, one is astonished at the inferiority of the latter."

The views respecting the period in which the mound-builders lived, and their relations to the Indian tribes at the time of the conquest are moderate and sensible. The mound-builders were

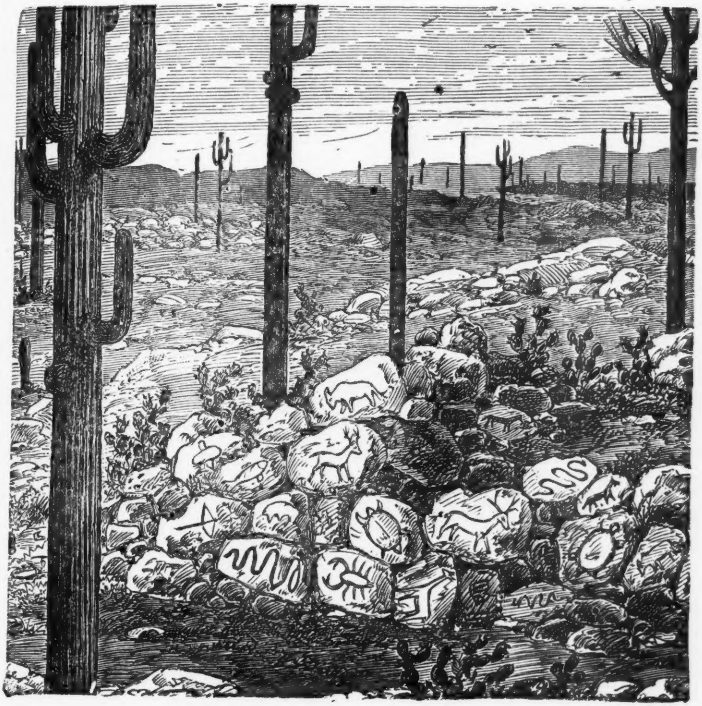


Group of Sepulchral Mounds.

a numerous, tolerably homogeneous people, with nearly similar funeral rites and much the same arts; they were sedentary, "for nomads could not have erected such temples or constructed such intrenchments;" they were also agricultural as well as fond of trading. "All testify to the fact that the men, whose traces we are seeking, had long since risen from the barbarism of savagery, and that they had attained to a state of comparative culture."

The Indians of Florida and Alabama, whose mound-building habits were described by Garcilasso de la Vega; those of Georgia, Tennessee, Mississippi and Arkansas, who disputed the advance of De Soto in their fortified walled towns; the Indians of Virginia and the Carolinas are probably the lineal descendants of the mound-builders, and thus the air of mystery thrown over the subject by popular writers and untrained archæologists has been of late years dispelled. As for the mounds themselves "a

lapse of thirty centuries or of five would account equally well for the development of the civilization they represent." Short's opinion is quoted with approbation that " one or at the most two thousand years only can have elapsed since the mound-builders were compelled to abandon the valleys of the Ohio and its tributaries, and but seven or eight hundred since they retired from the shores of the Gulf of Mexico. Lastly, the early explorers found mounds occupied and even being constructed within the last few hundred years."



Erratic blocks covered with figures, Arizona.

The accounts of the ruins and people of Central America and Peru are useful and timely, as is the chapter on the physical structure of the early man of America; the latter is often critical and with full references to the most recent authorities.

Our impression formed from reading and observation is that the view that there is an unity of race in North and South America, that the continent was peopled from Asia by way of Bering straits, and that the race shared the continent with only one

other race, the Eskimo, is most in accord with facts. We do not see that there are grounds for considering that any race on American soil was any lower in body, mind or culture than the existing Indians and Eskimo. Archæology has failed to indicate the existence of a race intermediate between the apes and man. Wherever traces of human beings occur, they indicate that man has everywhere appeared as man. Traces of a "missing link" may yet be discovered. Any day may bring forth the proof, but sound reasoning from observed facts does not yet show that fossil man in Europe or America was any lower, if so low, as the existing Australians. To say with Nadaillac that primitive man once existed in America "in a state of the lowest barbarism, and but little elevated above the brutes, at an exceedingly distant epoch," is to state what has not been proved. The high state of development and culture attained by the majority of the Indians of North America at the time of the discovery is to us a continual source of surprise; the high degree of culture of the Eskimo, perhaps the most primitive race existing, is, in some respects, almost startling. We are far away from any traces of the missing link. The so-called "Tertiary" man, most often Quaternary, in regions where glaciers never existed, seems almost beside the question in the present state of our knowledge.

The volume is elegantly printed, fully, almost lavishly illustrated, and on the whole is the most comprehensive and readable view of this entrancing topic one can now obtain.

INGERSOLL'S COUNTRY COUSINS.[1]—Country Cousins is the title of a little book of breezy natural history stories, most of which have previously appeared in the *Century*, *St. Nicholas*, the *Field* (London) or other periodicals. Such books as these, full of true inner life of animals, brimming over with psychology without burdening their pages with the long word, do more to encourage a love of nature among the young, and to make biological students, than all the wearisome technicalities in which anatomists and zoölogists often indulge when writing for a public that needs plain talk. The squirrel-mother's care for the orphaned young is made the vehicle of much deep teaching; the shrews are depicted in all their true shrewishness; the birds of the brookside are interviewed at home; nature is visited in her winter quarters; the workings of a seaside laboratory are exhibited, and so on. Mr. Ingersoll has common-sense ideas on the subject of snake "fascination," and gives good directions for the formation and keeping up of a naturalists' club. The hibernation of bats, bears, etc., the vitality of marine animals, rattlesnakes, the life of an oyster and of his enemy, the starfish, are among the subjects pleasantly treated of in this attractive volume.

[1] *Country Cousins.* Short Studies in the Natural History of the United States. By ERNEST INGERSOLL. New York, Harper Brothers. 1884.

The Geology of Indiana.—The thirteenth annual report of the geology and natural history of this State, by John Collett, State geologist, fills a volume of 264 pages, with thirty-nine plates. The large folding geological map of the State has been prepared from the labors of Owen, Lawrence, Brown and Cox, as well as the present geologist and his assistants. The report of Mr. Leo Lesquereux is entitled, Principles of Palæozoic Botany, and is a most useful manual by the leading authority on this subject. It gives character and value to the report, and is fully illustrated. It will be easily understood by the lay reader. In the same useful direction is Dr. C. A. White's Fossils of the Indiana rocks, No. 3, which treats of the fossil animals of the coal measures of the State. Besides these chapters a due amount of space is devoted to the economic geology of the State by the State geologist and his assistants.

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GENERAL NOTES.

GEOGRAPHY AND TRAVELS.[1]

ASIA.—*Asiatic Notes.*—The peninsula of Kamtchatka is by the Russische Revue said to contain but 6500 people. There is no agriculture, and for food they rely mainly on the fish, chiefly salmon which throng the rivers in summer, and are dried and stored for the winter. On account of the scarcity and dearness of salt the fish often decompose, and the people suffer great privation. For clothes, utensils, tea, tobacco, they have to look abroad, and their imports, paid for in sable skins, are almost wholly from California. A chain of volcanic mountains, reaching 5000 feet in height, runs down the center of the peninsula, and through this the large navigable river Kamtchatka makes its way to the Pacific. ——M. Leon de Rosny, the Japanese scholar, insists that the Aino is one of the two chief factors in the present Japanese race. He believes the Aino element to be a large one, and bases his arguments on an examination of the cosmogony, which contains two separate and distinctly marked mythologies, one of which is transparently aboriginal. Thus the Japanese of to-day is, in his opinion, a mixture of the conquering yellow and the conquered white races.——The celebrated French traveler, Charles Huber, who has, since 1879, been engaged in the exploration of the archæological remains of Central Arabia, was killed on July 30th, at Tafua by Bedouins of the tribe of Harb, while on his way from Hail to the Persian gulf.——Steers and Calmeyer islands, the product of the Krakatoa eruption, have again sunk, as has also an island a mile east of Verlaten island.——In 1868 a Russian surveying officer accidently discovered in the Altai mountains the settlements of some Russian sectaries who had migrated thither during the last century. Recently the governor-general of Irkutsk, in a progress through his province, came upon a town called Ilim, with four churches and 150 houses. The town was governed by a *vetche* or public assembly, convoked by the ringing of a great bell, as at Novgorod the Great in its republican days. None of the inhabitants could read or write. The traveler Adrianen found settlements of sectaries, founded in 1800, at Tobut on Lake Koko-nor. These colonists had acquired savage and predatory habits.——M. A. Marche has explored the Calamienes archipelago south-west of Mindoro and north of Paluan. The three chief islands are Busuanga, Calamienes or Culion, and Linacapan. The natives of Culion are Tagbannas, an ancient people found also in Paluan, and probably spread formerly over a wider area. Some few are Christianized, but most are independent, and are fetich-worshipers. In the island of Dibatac, hills surround a horseshoe-shaped plain with a depression in the cen-

[1] This department is edited by W. N. LOCKINGTON, Philadelphia.

ter—perhaps volcanic.——A new map of Saghalin, prepared by M. Nikitine, shows that island to be considerably larger than was supposed. While M. Reclus gave the area as 63,600 square kilometers, M. Venukoff calculates that 73,529 is a nearer approximation. ——It has been hitherto thought that the Gilbert islands were fast wearing away by the action of the sea during western gales. The belief was based upon the absence of the lee or western reef on some islands, and the anchorage afforded on the lee side of others, but a trader who has resided four years on Peru or Francis island states that when he came he could pass through the reef passage with a loaded boat at all states of the tide, whereas now the passage is dry at low water. From this and other indications it is believed that the island has risen two feet in the four years.

AFRICA.—*Results of the Journey of Mr. Jos. Thomson.*—West of Mombasa, on passing the Rabai hills, lies the undulating country of Duruma, densely covered with bush and tangle and thorny scrab. The miserable natives of this district are in perpetual dread of famine and of the spears of the Masai. At three days march from Mombasa an uninhabited country is reached, and by the fifth day a glaring sterile red sand marks the change from sandstone to schists and gneiss, thorns and gnarled trees replace the bush, and the land is flat. This waterless uninhabited wilderness extends from Usambara and Paré in the south to Ukambni and the Galla country in the north, and from Duruma in the east, to the volcano of Kilimanjaro westward; broken only by the mountains of Teita, arising like precipitous islands in a muddy sea to from three to seven thousand feet. On the western side of this desert, and somewhat eastward of the south side of Kilimanjaro, lies the district of Taveta, a bit of tropical forest on the banks of the snow-fed Lumi. The natives are a mixture of the Bantu tribe of Wa-Taveta with Masai who have been forced by the loss of their cattle to an agricultural life, and are a manly, pleasant, and honest, though immoral race. Kilimanjaro, the central mass of this region, has two summits, one the grand dome or crater of Kibo, towering above the forest-clad pediment of Chaga (where Mr. H. H. Johnstone is now residing with the chief Mandara) to a height above the sea about 18,880 feet; the other the pinnacle of Kimawenzi (16,250 feet) with its dark rocks and jagged outlines. The base of the mountain near Taveta is dotted with parasitic cones, and a few miles to the north of Taveta lies the small crater lake of Chala, in the center of a crater about two and a half miles across. The southern slopes of Kilimanjaro are (according to Mr. Jos. Thomson, from whose recital before the Royal Geographical Society these particulars are taken) carved into varied scenes of hill and dale by numerous streams, which rise high upon the flanks, and upon Mr. Thomson's map are shown as united into one river further south. The Lumi falls into Lake

Jipé, a small elongated lake south of Taveta, and this lake is shown as having an outlet into the system of streams which flows from the mountain slopes to the westward. On the eastern side of Kilimanjaro the sources of the Tzavo gush forth at the base, but on the northern side stretches the great plain of Ngiri, once, as is proved by the ponds and swamps yet remaining, the bottom of a lake. Ngiri is 3550 feet above the sea. Not a stream descends from the mountain on its northern side.

Lakes Naivaha and Baringo prove to be both of small size. The latter especially has shrunk, from the liberal dimensions accorded it upon the best maps published before Mr. Thomson's journey, into an island-dotted sheet about a quarter of a degree in length. Both lakes occupy portions of a longitudinal trough, akin to that in which the Dead and Red seas are lodged, and running north and south for an immence distance; flanked to the east by the Kaptè plateau, and westward by the escarpment of Mau. This depression was reached by Mr. Thomson from the south, after passing through Ngiri and through the Matumbato, a sterile but somewhat watered and inhabited broken country with red soil. South of Naivasha the trough is occupied by a desert, and the caravan ascended the Kaptè plateau for food and water, resting awhile at Ngongo-a-Bagas (6150 feet) near the source of the river Alhi, which waters the country of Ukambani farther to the east. A little to the south of Lake Naivasha is the remarkable conical extinct volcano Donyo (mountain) Longonot. This rises 3000 feet above the plateau or 9000 above the sea, and the edge of the crater, which is about two miles across, is so sharp that a man can sit astride of it. Lake Naivasha is a comparatively shallow freshwater lake, about twelve miles long by nine wide, formed by the piling up of volcanic débris across the trough in which it stands. Cones and craters, the steaming mountain of Buru, faults producing angular outlines, and hot springs, attest recent volcanic activity. Further north, at Lake Baringo, the eastern side of the meridional depression is formed by the Lykipia mountains, which rise nearly 8000 feet abruptly above the lake. Opposite tower the Elgeyo precipices to a height of 7750 feet, a northern continuation of the Mau escarpment. The depression is here longitudinally divided by the Kamasia mountains. Lake Baringo lies west of these, while in the narrow valley between them and Elgeyo the Mbage or Weimei river runs toward the north through the Galla country to the salt lake Samburu.

Near Lake Naivasha Mr. Thomson, with a party of thirty men, left the main caravan, ascended the plateau to the east, here called Lykipia, and made his way to the foot of Mt. Kenia, hitherto unvisited by any European. The rivers of this region flow into the as yet unexplored Guaso Nyiro. On the way to Kenia a range of mountains, running north and south, and rising to nearly 14,000 feet was crossed. These were named the Aberdane moun-

tains. Kenia, like Kilimanjaro, is a volcanic cone. The base is nearly thirty miles across, and its sides slope upwards at a low angle, almost unbroken by ridge or glen, to a height of 15,000 feet. Above this rises a sugar-loaf peak, with glittering facets of snow on its upper 3000 feet, yet with sides so steep that the snow will not lie in many places. At this point the enmity of the Masai, coupled with the atrocious nature of the food, which as all the cattle were dying of some plague, consisted liberally of rotten meat, compelled a retreat in the direction of Lake Baringe.

Westward from the Elyeyo precipices extends the vast treeless plain of Guas-Ngishu, bounded northward by the great volcanic mountain of Masawa or Elgon—a counter part of Kenia without the upper peak. Farther northward lies the occasionally snow clad mountain Donyo Lekakisera. The country of Kavirondo lies to the west of the shelterless plateau, and surrounds the north-east part of Victoria Nyanza. It extends to within forty miles of the Nile, and does not reach more than thirty miles south of the equator. A considerable part of this tract lies where Victoria Nyanza is shown upon our maps. The Wa-Kavirondo are a pleasant people, dangerous only when excited or drunk, and though the similarity of houses, manners, mode of life, etc., suggest unity of race, are really, as their language indicates, formed of a mixture of Wa-swahili with Nile tribes, the latter predominating southward. Kwa-sundu is a large town, and food can here be obtained in marvelous abundance and cheapness. The Wa-kavrondo wear no clothes, unless a small bunch of cord, worn tail-fashion by the married women only, can be styled an article of clothing.

Mr. O'Neill's Explorations.—The journey recently undertaken by Mr. H. E. O'Neill to Lakes Shirwa and Amaramba has solved the problem of the sources of the Lujenda. That river does not rise in Lake Kilwa or Shirwa but flows from Lake Amaramba, which is connected by the river Msambiti with Lake Chireta. These small lakes lie north of Kilwa, which has not been known to connect with their drainage within the memory of man, although the slight difference in level between the Mikoko river (which flows into Lake Kilwa) and the Mtoradenga swamp is so light that such a connection may probably follow unusually heavy rains. Mr. O'Neill believes that the Rev. Mr. Johnson's statement that Lake Kilwa has its outlet in the Lujenda is due to a mistake, and that the spot visited by Mr. Johnson was really the northern end of Lake Amaramba. The description of the scenery given by Mr. Johnson tallies with that at Amaramba, and the natives, who told Mr. O'Neill that he was the first white man who had visited Kilwa, remembered the visit of an European to Amaramba. The water of Lake Kilwa is brackish, that of the more northern lakes sweet and drinkable.

On his return to the coast Mr. O'Neill took a more southerly

course, with the object to discover some practicable channel of communication with the natives of the large area of country lying between Lake Nyassa and the coast. A large portion of this country, marked upon the maps as Makua land, is really occupied by the Lomwe. The valley of the Likuga is very thickly peopled, as is indeed the entire country except near the coast where the long continued slave trade has caused depopulation. Mr. O'Neill believes the reverenced Namuli peak to be an extinct volcano, the upper cone of which has disappeared. The Lomwe of the Likugu are a strong tribe and have a bad character among the slave-dealing traders who are not allowed to pass through their country. Their houses are oblong, strong, and with doors and veranda high enough to be entered without stooping. The only rivers that extend a considerable distance inland between the Zambezi and Lujenda are the Miuli, Ligonya, Mlela and Likugu, but none of these furnish a waterway into the interior, which can, in Mr. O'Neill's opinion, be reached most conveniently from Lake Nyassa and the Shiré.

In a subsequent journey Mr. O'Neill has traced the course of the Ruo river, which has been brought forward as the natural and proper boundary of the Portuguese in this direction.

GEOLOGY AND PALÆONTOLOGY.

The Position of Pterichthys in the System.—It is probable that the most primitive type of vertebrate of which we have any knowledge in a fossil state is the genus Pterichthys, if vertebrate it can be called. No intelligent attempt has as yet been made to assign this animal to its exact position. The opportunity of examining specimens of the *P. canadensis* Whiteaves, having been afforded me by Dr. A. R. C. Selwyn, director of the Geological Survey of Canada, I give here the results of my examination. Numerous specimens in which the anterior portion of the animal is well preserved, display three important peculiarities. There is a single opening on the middle line above. There are no orbits. There is no lower jaw.[1] The single opening may well be compared with the so-called nasal pouch of the lampreys. The absence of orbits is comparable to the condition in Amphioxus. In the absence of a lower jaw it agrees with both the types mentioned.

I have also instituted comparisons with the Tunicate genus Chelyosoma, of which the Smithsonian Institution, through the recommendation of Dr. Dall, has liberally placed at my disposal a fine alcoholic specimen from Point Barrow, Alaska. The scutellation of the dorsum of this animal agrees in every detail with that of Pterichthys, excepting in some of the small segments

[1] A pair of small, delicate laminiform bones found beneath the anterior end of the carapace are of uncertain determination.

about the lateral anterior border, and in the intercalated small plates which surround the anus between the first and second dorsal scuta. The anterior orifice is surrounded by six scuta distinct from the marginals, as in Chelyosoma. But they are differently arranged in the Pterichthyidæ, one forming a median valve of the mouth or *notosome*, and one being embraced in a larger posterior one.

The following hypothesis may be framed to account for these resemblances, which will also probably give Pterichthys its true position. The larva of Chelyosoma may be reasonably supposed to be caudate and notochordal, as are other Tunicata. In this stage its resemblance to Pterichthys would be great, especially if it possesses lateral limb-like processes as in Appendicularia, placed further forwards than in that genus. Possibly also in this stage the belly will be found to be shielded like the back, which would be

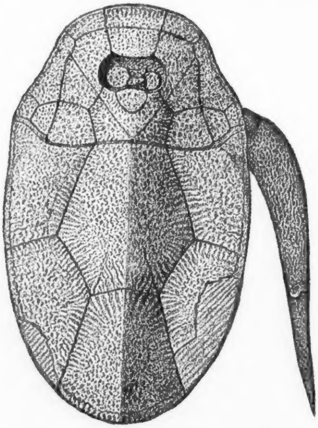

Fig. 1.

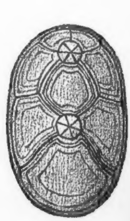

Fig. 2.

FIG. 1.—*Bothriolepis canadensis* Whiteaves, from above, half size of a small specimen. The valve of the dorsal mouth, or notosome, is broken. FIG. 2.—*Chelyosoma maclovianum* Brod. & Sow., $\frac{4}{3}$ natural size, from Point Barrow, Alaska.

a still further point of approximation to Pterichthys. From such a type I strongly suspect the latter genus to have descended. The principal change which it has undergone has been the substitution of the dorsal anus by the normal vertebrate position at the posterior extremity of the body. The tail has been retained in the European form.

If the above hypothesis be true, the single cephalic opening represents the tunicate mouth, and is the anterior extremity of the alimentary canal. This corroborates the theory that the "nasal pouch" and epiphysis or pineal gland of other vertebrates, represent the primitive mouth and œsophagus, as held by Geof-

ERRATUM.

Page 290, March number, on lines 6 and 18, for *notosome* read notostome.

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froy St. Hilaire, Owen and Lankester. On the other hand, in view of the absence of orbits, the theory of Ahlborn and Rabl Ruckard that these parts represent a primitive organ of sense or sight, must be taken into account. The close approximation of the orbits in some of the Cephalaspididæ might add plausibility to this opinion. This would require us to believe that Pterichthys is a monoculus, as it has no interorbital septum, and that the eyes of other Vertebrata have been derived from this single one by division and gradual separation of the halves. Such a view is not confirmed by the embryology of the eye, nor does it necessarily follow from the facts of palæontology. The resemblance between the median orifice of Pterichthys and the orbits of the Cephalaspididæ is probably delusive, and the latter family has probably very remote affinity to the Pterichthyidæ.

In view of the position of the mouth, it seems to me that this family should be removed from the Craniata to the Urochorda. It is true that the evidence that this orifice is a functional mouth is not entirely conclusive, as the transfer of the extremity of the œsophagus to the opening at the anterior extremity of the carapace may have taken place, as in the case of the anus. But there seems to be little doubt of the homology of the dorsal orifice with the mouth of Chelyosoma, and the structural resemblance to it decides in favor of the Urochorda rather than the Marsipobranchii. Among Urochorda it differs from the Tunicata in the position of the anus, which is the normal vertebrate, and not the dorsal orifice of the former division. It will, therefore, form a second order of the class Urochorda, which I propose to call Antiarcha.

It may be more than a coincidence that while the Chelyosoma is an arctic type, the Pterichthyidæ are so far only known from northern regions, Russia, Scotland, and the province of Quebec, Canada.

After an examination of at least fifty specimens of the *Pterichthys canadensis* neither Mr. Whiteaves nor myself have been able to discover any trace of a tail or of its scales. The possibility of this species having absorbed its tail like the Tunicates is increased by the fact that the posterior border of the carapace is not openly concave as in the *P. milleri*, but is regularly rounded as in Chelyosoma. I suspect that the *P. canadensis* belongs to a genus distinct from the *P. milleri*, which may, for the present, bear Eichwald's name Bothriolepis. The relations of Coccosteus to this order are not close, if the restorations given are correct, although it retains the same type of ventral plates.—*E. D. Cope.*

Types of Carboniferous Xiphosura new to North America.—We have received from R. D. Lacoe, Esq., of Pittston, Pa., for study and identification, a valuable collection of Carboniferous Xiphosura, mostly from the Mazon Creek beds at Morris, Ill. Besides a series of *Euproops danæ*, there is an undescribed spe-

cies of Belinurus, and of Cyclus, two genera new to this continent; also a new type probably referable to the Merostomata, which may be called Dipeltis. From the Carboniferous beds of Pennsylvania there is a new species of Euproops. It need scarcely be added that the discovery of these forms, new to our American Carboniferous fauna, is a matter of considerable interest.

Moreover, the specimen of Cyclus shows traces of four or five pairs of limbs, apparently of the same nature as those of the larval Limuli, proving that Cyclus is in reality, so to speak, a tailless Limuloid. We are able also to report the existence of cephalic appendages in Euproops, as seen in a well-preserved *Euproops danæ*, received from Mr. J. C. Carr, of Morris, Illinois.

We will add brief descriptions of the new forms, reserving figures, fuller descriptions, and measurements for a future occasion.

Belinurus lacoei, n. sp.—Cephalic shield, with a long lateral acute spine on each side extending to a point either opposite or a little behind the middle of the urosome (abdomen), or nearly to the base of the caudal spine. The urosome much more rounded and shorter than in the European *B. reginæ*, being about twice as broad as long. The caudal spine is long and slender, nearly one-half longer than the body, *i. e.*, longer than the whole body by the length of the head. Length of body including caudal spine 33$^{mm.}$ In nodules at Mazon creek, Morris, Ill. Collection of R. D. Lacoe.

Euproops longispina, n. sp.—The median lobe of the cephalic shield is larger in proportion to the entire shield than in *E. danæ*, and the eyes are much nearer the lateral margin. Ocelli distinctly marked (not before observed in the Carboniferous Limuloids), situated on the median ridge of the median lobe of the head, a little behind its anterior termination, and a little in front of a line drawn through the compound eyes. The lateral spines are much longer than in any specimen of *E. danæ* from the Morris, Ill., beds, being long and slender, extending nearly or quite to the base of the caudal spine. No. 214^{a} Oakwood colliery, Wilkes-Barre, Pa. Length of body without the caudal spine 30^{mm,} breadth 37^{mm}; a smaller specimen (Nos. 215^{a,} 215^{b}), from Butler mine, Pittston, Pa. Collection of R. D. Lacoe.

Regarding the position of the Illinois and Pennsylvania beds containing these fossils, Mr. Lacoe writes me: "The horizon of the Pennsylvania specimens of Euproops is much higher than that of Mazon creek. The latter is at the very base of the productive coal measures in shale over the bottom seam of coal. The specimen from the Butler mine, Pittston, is from shale over coal 'E' (Mammoth vein), at the top of the lower productive coal measures, about 300 feet above, and that from the Oakwood colliery is either from the same horizon or the bottom of the lower barren measure next overlying it. The shaft from which it was taken, penetrating both the exact position of the rock con-

taining it could not be ascertained when we discovered it in the 'dump' or rock-pile."

Cyclus americanus, n. sp.—In a nodule from Mazon creek, Illinois, received from Mr. Lacoe, I recognize a species of this rather obscure genus which has not before occurred in North America, but is represented in Europe by nine species.

In form *C. americana* is perfectly orbicular, the length being exactly equaled by the breadth. It is regularly disk-shaped, flattened hemispherical, with the edge of the body broadly and regularly emarginate, the margin being thin and flat, and apparently a little wider on the sides than on the anterior or posterior end. Length $14^{mm,}$ breadth $14^{mm.}$

None of the species yet described have had limbs, and nothing was known, so far as we are aware, of the nature of the limbs. Fortunately there are in Mr. Lacoe's specimen traces of four, and perhaps five pairs of limbs, showing that Cyclus had short, stout cephalic appendages, which, when extended, reached near the edge of the cephalic shield. They evidently were like the legs of the larval Limulus and the Belinurinæ, though the extremities are not preserved sufficiently well for us to ascertain whether they ended in forceps, as in Limulus, or not, though they probably did.

Another fortunate discovery is that of the nature of the cephalic appendages of Euproops. In a nodule received from Mr. J. C. Carr, all the ambulatory limbs, except the first pair, are distinctly preserved, with faint traces of the shorter first pair which have the position and relative size of those of the larval Limulus just before hatching. The cephalic limbs of the second, third, fourth and fifth pairs are of nearly the same size, the fifth pair slightly longer, as the tips reach near the edge of the cephalic shield. Each pair is chelate, the forceps being well developed, and distinctly seen in the third and fourth pair. The sixth pair differ from the others as in Limulus, and almost exactly correspond to the shape of the larval Limulus figured in our first memoir on Limulus (our Figs. $23^{d,}$ 24^{a} and 25^{a}), though perhaps a little shorter. Thus Limulus passes through a trilobitic, and afterwards a Belinurus stage. The species of Cyclus may be referred to a distinct family group for which we propose the name *Cyclidæ*.

Dipeltis diplodiscus, gen. et sp. nov.—This name is proposed for a singular form which is not satisfactorily preserved, so that its exact relations are not readily determinable, though it will be recognizable as a Cyclus-like form. The body is suborbicular, flattened, disk-like, sloping regularly and gradually from the median area to the edge; it is divided into two portions; the larger one to be regarded as anterior or the cephalic shield, and the other as posterior, constituting the abdomen (urosome). The edge of the body is very slightly emarginate, not broadly so as in Cyclus; nor is the body distinctly trilobate as in the Limulidæ, though

unfortunately the median area of the cephalic shield is wanting. The integument is rather thin, showing no traces of segments; its surface may have had a few scattered small tubercles, at least there are slight indications of them. The surface is smooth and shining.

The cephalic shield is nearly twice as broad as long; the posterior lateral angle is well-rounded, with no sign of a lateral spine; in front the edge was probably obtusely rounded; the surface is slightly convex, the disk being low and flat; the hind edge of the shield is moderately concave, the limits between it and the urosome being clearly indicated by a slight, but distinct, regular curvilinear suture.

The urosome is about three-fourths as long as, but equal in width to the cephalic shield. The front edge is somewhat arcuate, so that the projecting anterior-lateral angle is directed a little forward, and is quite free from the lateral angle of the cephalic shield, which turns away anteriorly from it, leaving a triangular space between the sides of the two regions. Posterior edge of the urosome regularly rounded, and with slight margin. No traces of a caudal lobe or spine. Total length 20^{mm}; total breadth 20^{mm}; length of cephalic shield 11^{mm}; breadth 20^{mm}; length of urosome, 9^{mm}; breadth, 19.5^{mm}. Collection of R. D. Lacoe, 2017 $^{a, b, c,}$ in a nodule from Mazon creek, Morris, Illinois.

This remarkable animal was disk-like in shape, composed of two regions, the head and abdomen or urosome, which are more distinctly separate than in the Cyclidæ; yet there are no positive characters to separate it from this group, to which we would, for the present at least, refer it, as it is orbicular, tailless, and consists of a broad, large cephalic shield, with a shorter urosome. —*A. S. Packard.*

Geological Notes.—*General.*—E. Cortese (*Bull. Comit. geol. d'Ital., 1882*), gives the result of his studies of the geology of N. E. Sicily. The crystalline mica schists and gneiss form mountains continuing those of Calabria; above them lie blackish-gray, pearly, lustrous, folded phyllites, probably Silurian, associated with the granite of Savoca, the felsite of Castelmola, and the tourmaliniferous pegmatite of Cape Calava, and with dolomitic and crystalline limestone. The crystalline mass of Cape Calava is probably Devonian. In the neighborhood of Ali on the east coast the phyllite is followed by quartzite, associated with slates, sandstone and conglomerates. Above these lies the gray limestone, of which Cape Ali is formed, and in other places yellow and violet shales, quartzite, and hornstone are alternated, and these are followed by a reddish quartzite, variously colored shales and gypsum. These may be Permian, they are not in contact with the succeeding trias. The mesozoic beds are not extensive, but are variously developed. The lower trias, muschelkalk and

upper trias exist, the latter commencing with well-developed beds of red and white dolomite. At Cape Taormina Rhætic beds are seen. The various stages of the Lias can be identified by their fossils, and the series is completed by the chalk, which appears only at one spot (Coll. Re.)

Silurian.—At a recent meeting of the Paris Academy of Sciences, M. Daubrée called attention to the discovery, by M. Buneau, in coal belonging to the Lower Carboniferous, of the remains of a species of Equisetum, a genus not previously known to occur below the middle coal measures. The remains of the stems occurred with various Diplothemema and Calymmatotheca, which proved the stage to be the upper grauwacke. The species has been named *E. antiquum.*——M. A. Milne-Edwards announced the discovery in the Silurian of Scotland, of a new scorpion absolutely identical with that which had previously been found by M. Lindstrom in the upper Silurian of the island of Gothland. The only difference is one of sex, the one being male, and the other female.——M. Brongniart recently called the attention of the Paris Academy of Sciences to a fragment of rock belonging to the middle Silurian, and containing the impression of an insect's wing, that of a cockroach, differing from all other blattidian wings, recent or fossil, in the length of the anal nerve, and the width of the axillary field. M. Brongniart called this ancestor of the cockroaches *Palæoblattina penvillei*, and stated that it was more ancient than the scorpion found by M. Lindstrom, since it belonged to the middle instead of the upper Silurian. The insect fauna of Carboniferous age is already known to be large; the beds of Commentry alone have furnished thirteen hundred.

Carboniferous.—M. Ed. Bureau states that the basin of the Lower Loire is probably the only part of France which presents at once the three stages of the Carboniferous formation. The great Silurian depression between Brittany and La Vendee is formed into parallel furrows, of which the central contains coal of the age of the second half of the Lower Carboniferous stage; while the northern was filled with carboniferous deposits at the middle of the middle Carboniferous; the southern at the end of the middle Carboniferous, and finally a bed was deposited above the lowest one toward the middle of the upper Carboniferous stage.

Jurassic.—M. Cotteau has presented to the Paris Academy of Sciences, a new work on Jurassic Echini. This includes the description of the species of Polycyphus, remarkable for their small dimensions and their numerous tubercles; also of Phymechinus, as yet only found in Jurassic strata, and near Stomechinus, which it resembles in its imperforate and non-crenellated tubercles, but from which it is well distinguished by the bigeminal arrangement of its pores.——C. F. Parona (Mem. Accad. dei Lincei, 1883) gives a list of the mollusks and brachiopods of the Lias of the central Apennines.

Tertiary.—M. V. Lemoine compares Pleuraspidotherium, a mammal from the Cornaysien fauna of Reims, on the one hand with *Pachynolophus gaudryi*, and on the other with *Phalangista vulpina* of New South Wales. The dental formulæ of Pleuraspidotherium and Phalangista, are practically identical. The bones of the face are remarkable for the development of the intermaxillaries and nasals, and for the almost complete ossification of the palatine vault. The lower jaw has a broad commissure, as in Pachynolophus, and a special development of the posterior branch recalls Phalangista, but is not inclined inwards.——M. F. Fontannes catalogues the pliocene mollusks of the valley of the Rhone and of Rousillon. These include 195 species of gastropods, of which 44 are new; and 146 bivalves, of which 24 are new. The same writer describes the shells of the fresh-water and brackish group of Aix in Lower Languedoc, Provence, and Dauphine, 92 species in all, 11 of which belong to Potamides, 11 to Striatella, 3 to Melania proper, 3 to Ripa, 14 to Lymnæa, and 12 to Cyrena.——M. Neumayr (Neues Jahrb. für Min., Geol. und Palæon., 1884) draws attention to the great similarity between the molars of Tritylodon Owen, from Cape Colony, and the molar of Triglyphus, described by Fraas from a bone bed near Stuttgart.

Quaternary.—A. Mehring (Kosmos, 1883) gives faunistic proofs of the former glaciation of North Germany. Against the "drift theory," he urges that the greater portion of the low-lying parts of North Germany are either entirely free from animal remains, or enclose only land and fresh-water forms, which could not have been the case had a diluvial sea existed. Even the finding of marine animal remains in certain spots can be explained by position from southward moving glaciers. The nature of the deposits and other characters shows that the arctic fauna, the remains of which are found, had its home in the surrounding region.

MINERALOGY AND PETROGRAPHY.[1]

OPTICAL ANOMALIES IN CRYSTALS OF THE REGULAR SYSTEM.—The two well-known theories generally advanced to account for the action on polarized light, exceptionally exhibited by certain regular minerals (vid. NATURALIST, November, 1882, p. 926, and Feb., 1884, p. 184) have recently undergone an important modification due to the discovery by Mallard, that sections of boracite, when heated above 265° C., become perfectly isotropic.[2] As is now generally known, Mallard, Tschermak and their followers accounted for these optical anomalies by what is termed "pseudo-symmetry," *i. e.*, the imitation, by certain crystals, of a geometri-

[1] Edited by DR. GEO. H. WILLIAMS, of the Johns Hopkins University, Baltimore, Md., to whom all papers for review should be sent.

[2] Bull. Soc. Min. de France, T. VI, 1883, p. 122.

cal form of a higher grade of symmetry than they themselves actually possess, by complicated and repeated twinning. Klein, Krocke and certain other German mineralogists, on the contrary, maintained that the optical peculiarities were produced, not by twinning but by a molecular disturbance due to an internal tension caused by the irregular growth of the crystal.[1] Klein had even succeeded in proving that the apparent twinning lines—the boundary between the areas of different optical orientation—could be made to move by raising the temperature,[2] and the interpretation put by the same writer on the interesting observation of Mallard is very important, as offering a possible means of reconciling the different views which have hitherto existed regarding these anomalous optical phenomena. Klein suggests that the fact that boracite becomes isotropic above 265° C., proves that this substance is dimorphous, crystallizing in the regular system above, and in some other, probably the orthorhombic, below this temperature.[3] The crystals must therefore have been formed at a temperature above 265° C., and hence possess geometrically the regular shape; their internal condition is due to the effort on the part of the molecules to rearrange themselves in accordance with the altered conditions, which is strong enough to produce a profound optical disturbance, but is not able to pull to pieces the crystalline form. Boracite crystals at ordinary temperatures are, in fact, a kind of paramorph, composed of optically orthorhombic portions enclosed in the regular framework in which the substance originally, at a higher temperature, crystallized.

Still more recently Klein[4] has shown that leucite becomes isotropic at high temperatures, and Merian[5] obtained a similar result for tridymite; thus it seems very probable that many other substances, like garnet, analcite, perofskite, senarmontite, etc., which show optical properties in no accord with their external form may be satisfactorily explained by the assumption that they are dimorphous.

Another class of substances like potassium sulphate,[6] leadhillite, aragonite, etc., whose optical properties at ordinary temperatures are in perfect accord with their crystalline form, have been shown capable of transference by increase of temperature to a state where their optical properties have a higher grade of symmetry, and consequently are no longer what the form would require, *e.g.*,

[1] Neues Jahrbuch für Min., etc., 1881, I, pp. 255 and 256.

[2] *ib.* p. 239, *et seq.*

[3] Neues Jahrbuch für Min., etc., 1884, I, p. 239. *ib. ref.* pp. 185 and 186.

[4] Nachrichten d. Kön. Ges. d. Wissensch. zu Göttingen, May, 1884, and Neues Jahrbuch für Min., etc., 1884, II, p. 50.

[5] Neues Jahrbuch für Min., etc., 1884, I, p. 193.

[6] Mallard: Bull. Soc. Min. de France, T. v, 1882, p. 219.

both orthorhombic aragonite[1] and monoclinic leadhillite[2] become uniaxial when sufficiently heated.

Mineral Synthesis.—Nearly everything heretofore done in the way of artificially reproducing natural minerals and their associations in rocks has been produced in France (vid. Naturalist, July, 1883, p. 780). Here, however, the results attained have been very interesting and important, and it is to be noticed with pleasure that the broad field which the researches of the French investigators have shown to be so fruitful is beginning to be successfully cultivated in Germany. Professor Doelter, of Graz, commenced, in connection with his colleague, Dr. Hussak, by studying the effects produced on various silicates by subjecting them to the action of different molten rocks.[3] Augite yielded but small results, while hornblende was partially dissolved and changed to an aggregate of opaque grains and microlites of augite, as is often observed in many volcanic rocks. Mica, garnet, olivine, quartz, feldspar, zircon and cordierite were treated in the same manner with different results, which cannot here be enumerated in detail.

A later series of experiments by the same authors for the purpose of obtaining garnet and vesuvianite, if possible, by fusion gave only a negative result.[4] All varieties of these minerals, when melted and again allowed slowly to cool, produced meionite, melilite, anorthite, lime-olivine, lime-nepheline, hematite and spinell, together with more or less amorphous matter, but no trace of the original minerals ever appeared. The fusion of mixtures of the substances entering into the composition of garnet yielded no better results. It would therefore appear that something more than simple dry fusion is necessary to produce these two minerals.

Doelter has still more recently busied himself with synthetical experiments on minerals of the pyroxene and nepheline groups. The lime and potash so often observed in the latter are probably isomorphous mixtures, since small amounts of $Ca\ Al_2\ Si_2\ O_8$ and $K_2\ Al_2\ Si_2\ O_8$, when melted with the typical nepheline molecule, $Na_2\ Al_2\ Si_2\ O_8$ gave homogeneous crystalline masses having all the properties of nepheline.[5] In regard to the aluminous pyroxenes, Rammelsberg holds that the $Al_2\ O_3$ and $Fe_2\ O_3$ are present as isomorphous mixtures with the normal silicate, $\dot{R}\ Si\ O_3$, while the view advanced by Tschermak is, that a silicate having the formula $\dot{R}O$, $R_2\ O_3$, SiO_2 accounts for the alumina and ferric iron. Doelter holds that the latter theory is the correct one, since he has artificially obtained the hypothetical molecule, $\dot{R}O$, R_2O_3, SiO_2,

[1] Klein: Nachrichten d. Kön. Ges. d. Wissensch. zu Göttingen, No. XII., 1883, and Neues Jahrbuch für Min., etc., 1884, II, p 49.
[2] Mügge: Neues Jahrbuch für Min., etc., 1884, I, p. 65.
[3] Neues Jahrbuch für Min., etc., 1884, I, pp. 18–44.
[4] Neues Jahrbuch für Min., etc., 1884, I, 158–177.
[5] Zeitschrift für Krystallographie, 1884, IX, 322–332.

and shows that its physical properties are those of pyroxene.[1] An optical examination of a series of carefully analyzed natural pyroxenes also yielded Doelter interesting results regarding the particular constituents which caused an increase in the size of the extinction angle on the clinopinacoid.[2] Wiik[3] attributed this to the amount of FeO present (vid. NATURALIST, Oct., 1882, p. 836), but Doelter considers it rather dependent on the proportions of the molecules $Fe\ Ca\ Si_2O_6$ or $\dot{R}\ \dot{R}_2\ SiO_6$ which the pyroxene contains, in this following the suggestion recently made by Fr. Herwig in his article on the optical orientation of the pyroxene-hornblende minerals.[4]

In this connection may be mentioned among the synthetical work lately produced in France, the artificial production of rhodonite, tephroite, hausmanite, barite, celestite and anhydrite by Alex. Gorgeu;[5] that of apatite and wagnerite containing Br in place of Cl by A. Ditte;[6] and that of albite, orthoclase and analcite in the wet way by Friedel and Sarasin.[7]

The reprint in book form of L. Bourgeois' article on the artificial reproduction of minerals, written for the Encyclopédie chimique,[8] is, notwithstanding Fouqué and Lévy's recent and very complete work on the same subject, a very valuable addition to the literature of this most interesting line of research.

BORON MINERALS.—Rammelsberg[9] has recently published the results of his new examination of the natural borates, which he arranges, starting with the metaboracic acid $\dot{R}_2\ B_2\ O_4$ as the normal, as follows:

Priceite (pandermite) $Ca_3\ B_8\ O_{15} + 5aq = \left\{\begin{matrix} 3Ca\ B_2\ O_4 \\ 2\ H\ B\ O_2 \end{matrix}\right\} + 4aq$

Boracite (stassfurtite) $2Mg_3\ B_8\ O_{15} + MgCl_2 = 2\left\{\begin{matrix} 3Mg\ B_2\ O_4 \\ B_2\ O_3 \end{matrix}\right\} + MgCl_2$

Hydroboracite $\left\{\begin{matrix} Ca_2\ B_6\ O_{11} \\ Mg_2\ B_6\ O_{11} \end{matrix}\right\} + 12aq = 2\left\{\begin{matrix} \dot{R}\ B_2\ O_4 \\ H\ B\ O_2 \end{matrix}\right\} + 5aq$

Boronatrocalcite (ulexite) $\left\{\begin{matrix} Na_4\ B_6\ O_{11} + 9aq \\ 2(Ca_2\ B_6\ O_{11} + 9aq) \end{matrix}\right\} = \left\{\begin{matrix} 2Na\ BO_2 \\ H\ BO_2 \end{matrix}\right\} +$

$2\left\{\begin{matrix} Ca\ B_2\ O_4 \\ H\ B\ O_2 \end{matrix}\right\} + 12aq$

Franklandite $\left\{\begin{matrix} Na_4\ B_6\ O_{11} + 8aq \\ Ca_2\ B_6\ O_{11} + 8aq \end{matrix}\right\} = \left\{\begin{matrix} 2Na\ BO_2 \\ H\ BO_2 \end{matrix}\right\} + \left\{\begin{matrix} Ca\ B_2\ O_4 \\ H\ B\ O_2 \end{matrix}\right\} + 7aq$

Borax (tinkal) $Na_2\ B_4\ O_7 + 10aq = 2\left\{\begin{matrix} Na\ BO_2 \\ H\ BO_2 \end{matrix}\right\} + 9aq$

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[1] Neues Jahrbuch für Min., etc., 1884, II, pp. 51–66.
[2] *ib.*, 1885, I, pp. 43–68.
[3] Zeitschrift für Krystallographie, VIII, p. 208.
[4] Schulprogramm des Kgl. Gymnasium, Saarbrücken, 1884, pp. 175.
[5] *Comptes rendus*, 1883, XCVII, p. 320, *ib.*, XCVI, pp. 1144 and 1734.
[6] *Comptes rendus*, 1883, XCVI, pp. 575 and 846.
[7] *Comptes rendus*, 1883, XCVII, p. 290.
[8] Paris, 1884, 8vo, pp. 228, VIII planches, Dunod éd.
[9] Neues Jahrbuch für Min., etc., 1884, II, 158–163.

Borocalcite (hayesine) $Ca\,B_4\,O_7 + 6aq = \left\{\begin{matrix} Ca\,B_2\,O_4 \\ 2H\,B\,\,O_2 \end{matrix}\right\} + 5aq$

Larderellite $Am_2\,B_8\,O_{13} + 4aq = 2\left\{\begin{matrix} Am\,BO_2 \\ 3H\,BO_2 \end{matrix}\right\} + aq$

Sussexite $\grave{R}\,B_2\,O_5 + aq = \left\{\begin{matrix} \grave{R}\,B_2\,O_4 \\ \grave{R}\,H_2\,O_2 \end{matrix}\right\}$ $(R = Mn, Mg)$

Szaibelyite $Mg_5\,B_4\,O_{11} + 3aq = \left\{\begin{matrix} 2Mg\,B_2\,O_4 \\ 3Mg\,H_2\,O_2 \end{matrix}\right\}$

Then might be added:

Lagonite $Fe_2\,B_6\,O_{12} + 3aq$

In ludwigite, danburite, datolite, axinite and tourmaline, B is regarded as merely substituted for Al or Fe. In warwickite it would appear to be the same.

The hexagonal mineral from Soktuj, Urals, proved by Damour to be normal borate of alumina, and named by him *jeremeiewite* (vid. NATURALIST, June, 1883, p. 651), has since been investigated by Websky[1] with most interesting results. The substance $Al\,BO^3$ is shown to be dimorphous, crystallizing like carbonate of calcium in both the hexagonal and orthorhombic systems. The interior of each crystal is a penetration twin of three orthorhombic individuals, closely resembling those often formed by aragonite, while this pseudohexagonal core is surrounded by an external layer of the really hexagonal modification. Both appear to have the same chemical composition. Websky proposes to retain Damour's name, jeremeiewite, for the outer, hexagonal form, and suggests that of *eichwaldite* for the internal, orthorhombic variety.——The monoclinic mineral, *colemanite* (vid. NATURALIST, September, 1884, p. 925), a hydrous borate of calcium closely allied to priceite, which was recently discovered at Dry lake, in Southern California, has been crystallographically investigated by both vom Rath[2] and Wendell Jackson.[3] By the former the axial ratio is given as $0.7769 : 1 : 0.5416$, $\beta = 69° \, 43\frac{1}{3}'$, observed planes $+P$, $-P$, $-3P$, $3P3\grave{}$, $2P$, $2P2\grave{}$, $P\grave{\infty}$, $2P\grave{\infty}$, $2P\bar{\infty}$, ∞P, $\infty P\bar{2}$, $\infty P\grave{\infty}$, $\infty P\bar{\infty}$, $0P$. Jackson determined the axial ratio as $0.774843 : 1 : 0.540998$, $\beta = 69° \, 50' \, 45''$. To the planes mentioned by vom Rath are added $\infty P\grave{\frac{7}{3}}$, $\infty P\grave{2}$, $\infty P\grave{\frac{19}{10}}$, $\frac{68}{11}P\bar{\infty}$, $6P\bar{\infty}$, $4P\bar{\infty}$, $+P\bar{\infty}$, $-P\bar{\infty}$, $-\frac{19}{6}P$, $2P\bar{2}$, $3P\grave{\frac{3}{2}}$, $4P\bar{2}$, $\frac{3}{2}P\grave{\frac{3}{2}}$, $3P\grave{3}$, $3P\bar{3}$, $-3P\bar{3}$ and $4P\bar{4}$. In all thirty-one forms, of which twenty-four appeared on one crystal.——C. Bodewig[4] contributes a critical comparison, based on many analyses, of the methods for a quantitative determination of boron in silicates.

[1] Sitzungsberichte d. Kgl. preuss. Ak. d. Wissensch, Berlin, 1883. Neues Jahrbuch für Min., etc., 1884, I, p. 1–17.

[2] Neues Jahrbuch für Min., etc., 1885, I, p. 77.

[3] Am. Jour. Sci., Dec., 1884, p. 447.

[4] Zeitschrift für Krystallographie, VIII, p. 211.

Stibnite.—The stibnite crystals from Japan, which Professor E. S. Dana has recently studied (vide NATURALIST, Nov., 1883, p. 1159) have also been investigated by Krenner[1] at Buda-Pesth and by Brun.[2] The former adds three new forms, $\frac{3}{17}P$, $\frac{3}{13}P$ and $\frac{5}{19}P$, to the seventy observed by Dana, making the whole number of forms now known on stibnite, eighty-eight. M. Wada,[3] of Tokio, in a recent paper read in Berlin on some Japanese minerals, gives the correct stibnite locality as Ichinokawa, in the town of Ojoin-mura near Saijo, Province Iyo, Island of Shikoku. Dana's locality is incomplete, since "*Kosang*," in Japanese means "mine," and "*Jaegimeken Kannaizu*," chart of the district of Jaegime.

BOTANY.[4]

SEEDLESS APPLES.—During the past autumn my friend, Mr. C. Gibb, called my attention to some seedless apples of the St. Lawrence variety. They were all from the same tree, and there were originally quite a large number. The normal diameter of the St. Lawrence apple may be given at about $7^{cm.}$ Examination of the specimens showed a somewhat conspicuously flattened form in axial direction; color chiefly yellowish-green; diameter varying from 2.9^{cm} to $5^{cm.}$ Longitudinal and transverse sections gave the same result in each case, and showed (a) complete suppression of the carpels, and so of the ovules; (b) suppression of the vascular structure to such a degree that no fibro-vascular bundles could be seen with the naked eye, as is usually the case.—*D. P. Penhallow, Montreal, Canada.*

WHY FLOWERS BLOSSOM EARLY.—Mr. Meehan in his Native Flowers refers to the early blossoming of *Symplocarpus fœtidus.* In the AM. NAT., Nov., 1883, I tried to show that most spring flowers had their next year's growth well developed in the underground buds of winter, and that spring simply called forth what was already prepared in the winter bud or hibernaculum of the plant. Mr. Meehan says that the flowers of the skunk cabbage must have been prepared to some extent already in the previous winter, and that this may account for their early blossoming. I found this to be entirely correct, and being curious to know the extent of development in our spring plants during the intense heat of summer, I opened a number of the subterranean buds of plants on the 25th and 26th of August. It may be of interest to know that next year's peduncle of the skunk cabbage was 45^{mm} long; the spathe was 55^{mm} long, its upper half being already mottled with purple and yellowish-green; the spadix was 20^{mm}

[1] Földtani Közlöny, 1883, XIII, p. 1.
[2] Arch. d. sciences ph. et nat. Genève (3), IX, p. 514.
[3] Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin, 17 Juni, 1884, 79–86.
[4] Edited by PROFESSOR CHARLES E. BESSEY, Lincoln, Nebraska.

long. The so-called flower, therefore, was almost half its full size. The flower and peduncle of *Anemone hepatica* were 4^{mm} long; of *Sanguinaria canadensis*, 3^{mm}; of *Arisæma dracontium*, 3^{mm}. The flowers of *Trillium grandiflorum* was 8^{mm} long.

The hibernaculum of *Aralia quinquefolia* in all the plants examined was composed of three scales, the innermost entirely sheathing next year's flowering stalk and also a small bud. The latter is in the axil of the scale, and is destined to produce the flowering stalk two years hence. The leaf of the flower stalk which is opposite to the last scale is always the largest. When the leaves occur in whorls of fours, as was frequent in the specimens at hand, the relative stage of development of the leaves and their position suggested a contracted spiral of leaves rather than a single and sessile twice-compound leaf, as suggested by Gray (Manual, p. 199). The flowers could easily be determined, the outermost flowers being developed the most. In view of the early development in bud of the flowers of spring plants, need their early appearance in spring be surprising? *Aralia quinquefolia* flowers in July, and in August of the same year shows ripened berries and the parts of next year's plant! Is it not rather surprising that with the small amount of vegetation it is compelled to produce, it does not flower much earlier?—*Aug. F. Foerste, Granville, Ohio.*

A Significant Discovery.—In a recent number of *Nature*, Mr. W. T. Thiselton Dyer calls attention to a most interesting and significant discovery in the development of certain ferns. Some months ago Mr. E. T. Druery observed in *Asplenium filix-fœmina*, var. *clarissima*, that the sporangia "did not follow their ordinary course of development, but assuming a more vegetative character, developed more or less well-defined prothallia," which ultimately bore antheridia and archegonia. "From these adventitious prothallia the production of seedling ferns has been observed to take place in a perfectly normal way." The prothallia were subsequently observed by Mr. F. O. Bower to be furnished with root-hairs!

The last-named observer was so fortunate as to discover a still more remarkable development upon *Polystichum (Aspidium) angulare*, var. *pulcherrima*. Here the apex of the pinnules grew out into an irregular prothallium, upon which antheridia and archegonia were clearly made out.

It is a genuine pleasure to note such discoveries, for they are just what we have reason to expect. If, now, so great a change in the ordinary course of development as this is, can take place so suddenly, does it not, to say the least, argue in favor of the *possibility* of similar changes in the past having given rise to the phanerogams? What essential difference is there between these aposporous ferns and the lower phanerogams? The most remark-

able feature about the discovery is the fact that it pertains to pteridophytes of as low a type as the ferns of the Polypodiaceæ. If it occurs there, may we not look for it confidently in the Lycopods, and especially in the Selaginellæ. It may be worth giving a good deal of attention to a careful examination of the greenhouse grown plants of the various species of Selaginella. Apospory in these would possess many interesting features. Who will search for it?

The History of Discovery in Ferns.—Mr. W. T. T. Dyer gives, in *Nature*, a summary of the progress of discovery with respect to the structure of the reproductive apparatus of the ferns. It is of so much interest that we reproduce it here:

1597	Gerarde	Observed seedling plants near parents.
1648	Cæsius	Sporangia.
1669	Cole	Spores.
1686	Ray	Hygroscopic movements of sporangia.
1715	Morison	Raised seedlings from spores.
1788	Ehrhart	Prothallium.
1789	Lindsay	Germination of spores.
1827	Kaulfuss	Development of prothallium.
1844	Nägeli	Antheridia.
1846	Suminski	Archegonia.
1874	Farlow	Apogamy.
1884	Druery	Apospory.

What better illustration do we need of the slowness of discovery?

De Bary's Comparative Anatomy of Vegetative Organs.—Between seven and eight years ago there appeared a most valuable contribution to the literature of histological botany from the pen of the great Strassburg professor. In its German form it has been familiar to workers in botanical laboratories, and has been of great service. Now we have an English translation by F. O. Bower and D. H. Scott, which has been brought out under the title of Comparative Anatomy of the vegetative organs of the Phanerogams and Ferns, by the Clarendon Press in England, and placed before the American public by the New York house of Macmillan & Co. In its English form it consists of about 675 octavo pages, having the general appearance both in type, illustrations, paper and binding of the well-known English editions of Sachs' Text Book.

For the benefit of those who are not familiar with the work, we give here its general contents:

Part I. The Forms of Tissue.

Chap. I. Cellular Tissue. (i) epidermis, (ii) cork, (iii) parenchyma.
" II. Sclerenchyma.
" III. Secretory Reservoirs.
" IV. Tracheæ.
" V. Sieve-Tubes.
" VI. Laticiferous Tubes.
" VII. Appendix. Intercellular spaces.

PART II. ARRANGEMENT OF THE FORMS OF TISSUE.

§ *1. Primary Arrangement.*

Chap. VIII. Tracheæ and Sieve-Tubes. (i) Arrangement, (ii) structure, (iii) development.
" IX. Primary parenchyma.
" X. Sclerenchyma and Sclerotic Cells.
" XI. Secretory Reservoirs.
" XII. Laticiferous Tubes.
" XIII. Intercellular Spaces.

§ *2. Secondary Changes.*

Chap. XIV. Secondary growth in thickness of normal dicotyledonous Stems and Roots. (i) Cambium, (ii) wood, (iii) bast.
" XV. Secondary changes outside the zone of thickening.
" XVI. Anomalous thickening in Dicotyledons and Gymnospores.
" XVII. Secondary thickening of the Stem and Roots of Monocotyledons and Cryptogams.

The publication of this work in this form will do much to stimulate a more exact study of the minute anatomy and development of the various organs of plants, and will, we trust, do not a little towards placing botanical work in this country upon something of the same basis as that of zoölogy.

JOURNAL OF MYCOLOGY.—There has been a feeling for a long while that this country should have a journal of mycology in which should be published all the descriptions of new species of fungi. The matter was talked over somewhat in Philadelphia last September by members of the Botanical Club of the A. A. A. S., and it has now so far taken form as to result in the issuance of a prospectus. It is to be "edited by J. B. Ellis, Newfield, N. J., and W. A. Kellerman, Manhattan, Kan. It will be issued about the 1st of each month, contain from twelve to fifteen pages, and be devoted exclusively to mycological botany, special attention being given to the North American Fungi. It will contain descriptions of new species as they appear from time to time; another leading feature will be the publication of monographs of different genera, with descriptions of all the North American species known—thus making, in fact, a manual of our fungi. A full account will also be given of all the current literature pertaining to this subject."

We bespeak for this much-needed journal a liberal patronage. The business management will be in the hands of Dr. Kellerman, to whom subscriptions ($1) should be sent.

BOTANICAL NOTES.—Friedlænder & Son, the well known booksellers of Berlin, have just issued three very valuable catalogues of books treating of cryptogamic plants. They are Nos. 357, 358 and 359, and we feel that we are doing good service to botanists in this country by calling attention to them.——J. G. Baker's Syn-

opsis of the genus Selaginella in the *Journal of Botany* has reached the 219th species, and is still to be continued.——L. A. Bailey continues his Notes on Carex in the January *Botanical Gazette*, describing one new species, *C. nervina*, and one new variety, *C. muricata*, var. *confixa*, both from the Pacific coast.——Dr. Vasey, in the last *Torrey Bulletin*, describes three new grasses, viz., *Stipa scribneri* from New Mexico, *Festuca confinis* and *Elymus saundersii*, both from Colorado.——In the same journal H. W. Ravenel gives an account of a monster grape-vine in Beaufort county, S. C., which at the ground measures fifty-nine and a half inches in circumference, and "at two and a-half feet from the ground, where it divides into two branches, fifty-seven and a-half inches in circumference."

ENTOMOLOGY.

The Flight of the Robber Flies during Connection.—Both fly vigorously though their heads are in opposite directions, the female, by her greater size, controlling the course. The difference in pitch of the two sets of wings is very striking.—*J. E. Todd.*

Notes on the Mounds of the Occident Ant.—The mounds built by the *Pogonomyrmex occidentalis* can hardly fail to attract the attention of any observing traveler.

A neatly smoothed bare spot, from three to five feet in diameter is found in the grass and in its center is a mound of quite symmetrical form. This mound is frequently covered entirely with coarse sand or fine gravel, even when the surrounding surface shows little of this material.

It would seem, at first, that the ants, guided by some instinct, selected the material which would best secure their structure from the wind and the rain.

During the past season the writer has found opportunity to test this point. A little watching showed that the excavation below the surface and the building of the mound are carried on by two different sets of workers, one continually bringing out particles from within and dropping them upon the court or bare space around the mound, the other picking up particles from the surface of the court and depositing them upon the mound. The coarseness of the material seems to be determined by the desire of a worker to find as large a particle as he can conveniently carry. For instance, when, as in the case observed, the crust of the ground was broken by the tramping of a horse, medium sized pieces were deposited upon a mound, but none of the smallest and of course none of the largest, as ants have not learned to work otherwise than individually. When particles of broken glass were scattered upon a court they were quickly found and in spite of their angular and polished surface were soon carried and dropped upon the mound. The coarseness and uniformity of the material,

therefore, seems readily explained by the principal stated above. Whether the mound shall eventually be formed of gravel depends upon its abundance in the particular locality.—*J. E. Todd.*

Notes on the Breeding Habits of the Libellulidæ.—The following observations, though incomplete, are offered because there is no prospect that the writer can pursue the subject farther, at least not for some time.

In the month of July, '82, while camping near Bear creek, Dakota, on a bright, breezy day, his attention was attracted to numbers of dragon-flies hovering over the surface of the water. Many of them were in the usual position when pairing. The male holding the female by the back of the head with his claspers.

From the bottom of a deep clear pool various water-plants came to the surface, and as the water was rippled by the breeze, their tops were occasionally thrown out of the water. Many dragon-flies were noticed hovering about, especially around the tops of these plants; the female evidently endeavoring to gain a footing upon them. In a short time one was successful and immediately folded her wings backward and commenced crawling down the stem into the water. The male meanwhile was forced to let go to prevent his being dragged into the water. I could see the females until they were about a foot below the surface of the water but of course could not trace them to the bottom which must have been at a depth of from three to five feet. They seemed the more conspicuous because of the quantity of air which adhered to their abdomen and wings. After losing his companion the male hovered about, resting occasionally upon the grass at the border of the pool, and evidently watching for the return of the female.

I was unable to determine, very satisfactorily, the length of time which the female remained below the surface, but after the first one observed disappeared below the surface fully half an hour passed before I saw one reappear. This one appeared struggling upon the surface of the water and was quickly seized by one of the males with his claspers. She seemed to have torn her wings so as to be unable to fly, but it may have been that they could not be promptly used on account of being wet. The male after seizing her towed her to shore, being apparently unable to lift her from the water. A male falling accidentally upon the water was not similarly rescued. The water was more or less infested with fish and it seems not improbable that many of these venturesome insects sacrificed their lives in devotion to their progeny.

Other pairs of the same or closely similar species were observed about the edge of the water, the female evidently fastening her eggs to the under-side of sticks and stems of weeds by extending her abdomen below the water while resting upon them. The species was not recognized and conveniences for collecting and pre-

serving were not at hand, but it resembles quite closely another species which has been determined by Dr. Hagen as *Lestes unguiculata.* The latter species, at another locality, was found depositing eggs in the stems of bulrushes and cat-tails, the male accompanying the female in a position similar to that in the first species named. The female saws a hole through the skin with her ovipositor and deposits the egg in the pith. Similar localities have been diligently watched by the writer during the past two seasons, but it has not been his privilege again to see the dragon-flies go below the surfacc of the water. The laying of eggs in the stems of bulrushes is a very common sight about the marshy ponds and streams of Dakota.

The different stages or positions in the process of copulation in the dragon-flies are very interesting and sometimes puzzling, but as a general rule they seem to be as follows:—at least it is so with the genus Lestes. First, the male seizes the female by the back of the head and flies some time with her in this position before the second stage is reached, in which the male, still holding the female, curves his abdomen and charges the seminal sac, then resumes the first position. The female seizes the abdomen of the male with her feet and brings the tip of her abdomen forward and receives the seminal fluid from its receptacle From the third the fourth is readily reached by the female withdrawing her abdomen and letting go with her feet or not as the case may be. In the species of Lestes before referred to the fourth position corresponds to the first. It seems not improbable that after laying a number of eggs the female may return to the second position and become fertilized for a second brood. The length of time which is occupied evidently varies considerably. In some cases I have observed, the males and females united during their rest at night. Another curious habit observed, especially in a large olive-green species of Æschna, is this: while flying at full speed the insect dashes flat upon the surface of the water in a pond and, apparently by the rebound, recovers its position in the air. This may serve the purpose of a bath, clearing the wings of dust, or possibly of parasites.—*J. E. Todd, Tabor, Ia., Jan. 10, '85.*

THE NUMBER OF ABDOMINAL SEGMENTS IN LEPIDOPTEROUS LARVÆ.—In connection with our examination of the caterpiller of Lagoa we have made an examination of the caterpillars of each of the families of Lepidoptera in order to ascertain whether there was any variation in the number of segments to the body and whether there were any more than five pairs of abdominal legs. We find that no caterpillars known to us have less than ten abdominal segments or uromeres. The ninth segment, however, is liable to be much reduced in size and to be more or less coalesced with the tenth or anal segment. The ninth segment is most rudimentary in the Sphinges, where it is very short, though yet dis-

tinguishable; beneath, the segment is distinct on the sides, but obsolete in the middle.

In the larval butterflies the ninth segment is rather more distinct than in the Sphinges, but it is short; the tenth segment is as in all caterpillars represented by the supra-anal plate and anal legs.

In the Ægerians, Zygænidæ and Bombycidæ, the latter especially, the ninth segment is very distinct. In Halesidota the ninth segment is quite long, forming an entire segment, with its own set of hair-bearing warts, the urite, or ventral surface is quite distinct from the infra-anal plate or tenth urite. In Datana the ninth segment is longer than the supra-anal plate; in *Lochmæus tessella* with its long anal filaments, the homologues of the anal feet, the ninth segment is distinct from the tenth; in an allied Notodontian with elongated anal legs, the ninth segment is unusually long and distinct. In *Telea polyphemus* there are ten abdominal segments, counting the supra-anal plate and anal legs as the tenth; in *Hyperchiria io* and Clisiocampa the ninth is distinct from the tenth segment

In *Limacodes scapha* and *P. pithecium* there are no traces of legs; the number of abdominal segments appears to be ten.

In the Noctuidæ the ninth segment is distinct, with a series of verticils above and a well marked ventral portion or urite.

In the geometers the ninth segment is distinct above but below merged into the infra-anal plate. In the Pyralid caterpillars, as well as the Tortricids and Tineids, the ninth segment is longer and more distinct than in the higher families.

Although the indications are slight, yet the Bombycidæ, as we have previously remarked, seem to be the oldest, most generalized group of Lepidoptera, and it is a question whether the Pyralids, Tortricids and Tineids are not degenerate forms which have descended fron the Noctuidæ and ultimately from the Bombycidæ; there are indications that the Noctuidæ have descended from the geometers, since the young of the Plusiæ and Catocalæ, &c., have three pairs of abdominal legs, being semi-loopers when hatched, and afterwards acquiring the additional pair of legs. At any rate the primitive caterpillar had ten pairs of abdominal legs.

It will be remembered that the saw-fly larvæ (*Lophyrus*) have eight pairs of abdominal legs, while the embryo honey-bee has tenpairs of temporary abdominal appendages.—*A. S. Packard.*

Entomological Notes.—Studies on the organs of flight in the Hymenoptera, by Dr. Amans, appear in the Travaux de Laboratoire de zoologie de la Faculté des Sciences de Montpellier et de la station Zoologique de Cette, 1884.——In *Psyche* for June–July, 1884, W. C. Krauss describes in detail, with sketches, the brain and nerves of the head and mouth-parts of *Corydalus cornutus.* ——In the *Zoologischer Anzeiger* for Nov. 15, 1884, Dr. J. E. Rombouts discusses the mode of progression of flies on smooth sur-

faces, and concludes that the fluid by which flies adhere to smooth surfaces is not sticky, that they need no adhesive secretion and that if the fluid were pure water or olive oil it would act the same and that the fly's power of walking on a smooth surface is due simply to capillary attraction. A firm adhesion of the hairs to smooth surfaces, which Hepworth in 1854, and Dahl and Simmermacher consider as necessary, he finds not to exist.——A memoir of great value on the anatomy of a Myriopod (*Lithobius forficatus*), with four colored plates and wood-cuts, but unfortunately wholly in Russian, was published in 1880, by N. Sograff in the Moscow Transactions.——In the Bulletin of the Brooklyn Entomological Society, Nov., 1884, Mr. G. Gabe claims that *Rhyssa lunator* is not a true ichneumon, but a true wood-feeder. The breeding habits are described, and the mode of oviposition. During the process the long ovipositor is bent, passed between the posterior legs, the abdomen is elevated almost to a right angle with the thorax, and the ovipositor, guided by the anterior tarsi is forced with a ramming motion into the wood to the depth of from two or three inches. He has watched many females ovipositing and has cut off the ovipositor when ready to be withdrawn, and in no instance has he found a larva of any kind anywhere near the point reached by the borer, and where the egg was deposited. Messrs. Hulst and Weeks stated that they had reached the same conclusion from independent observation.——During the past winter Prof. Packard has given a series of talks or lectures to the Providence Entomological Society on the structure and habits of insects, in order to aid those members whose time does not permit them to obtain a general knowledge of the subject.——The veteran French Coleopterist, Auguste Chevrolat, died Dec. 16th, in his 86th year.

ZOÖLOGY.

Function of Chlorophyll in Animals.—L. von Graff, dissatisfied with the conclusions of Brandt as to the symbiotic relations of what the latter regards as green algæ to *Hydra viridis*, and with the methods of his experiments, arranged three specimens of *H. viridis* in eight different vessels; four of them, A, B, E and F, he exposed to the light; A, B, C and D were filled with water from an aquarium. In E—G the water was filtered. In A, C, E and G the water was changed daily, in the others it was never changed at all. The first Hydra to die was one in glass G, on the thirty-first day of exposure in which the filtered water was changed daily, and the light shut off. The glass A did not lose a specimen till the 109th day of observation, when one died. In C in which the aquarium water was changed daily, and light shut off, the three specimens died on the 105th, 106th and 109th days; B, in which the water was not changed, and which was ex-

posed to the light, only lost one specimen, and that on the 100th day.

Dr. Graff concludes that the Algæ or pseudochlorophyll bodies of Hydra have no significance as means of nutrition; the fact that all the specimens in filtered water died by the 87th day seems to show that the Hydra died from the want of animal food, and that the green bodies do not serve as such, as Brandt supposes. The most unexpected and perhaps the most remarkable fact is that whether the Hydræ were exposed to the light or placed in the dark, they in all cases retained their green color through life.

Dr. Graff has lately been able to make some observations on the *Mesostoma viridatum*, three out of five examples of which were richly provided with chlorophyll-corpuscles; these varied very considerably in size, and no nucleus was to be detected in the smaller specimens; starch granules of proportionate size to that of the chlorophyll-bodies were found in them. The larger green bodies were arranged in closed groups, and the smaller examples lay between the groups; most of the bodies were rounded, but a few of the larger were oval.—*Journ. Royal Microscopical Society, Dec., 1884.*

A Free-Swimming Sporocyst.—The egg in the digenetic Trematode worms, as is well known, does not at once give rise to the adult Distome, but to a brood-sac which produces directly or indirectly in its interior a greater or less number of larval Distomes. The brood-sacs live parasitically within mollusks, and are known as rediæ or sporocysts, according as they have, or have not, a rudimentary intestine. Neither rediæ nor sporocysts are possessed of much locomotive power, but this appears to be in inverse ratio to the number of the contained brood. The sporocyst of *Cercaria micrura, e. g.*, which contains only a few larvæ is decidedly active. Sporocysts are commoner than rediæ, and exhibit a greater variety of form. Thus Moulinié distinguishes sacciform, cylindrical and tubular sporocysts, a classification which corresponds fairly well to the form of the contained brood. The sacciform sporocysts generally contain the ordinary tailed larvæ or Cercariæ, but the tail may be very short as in *C. micrura* Filippi, or entirely absent as in *C. globipora* Ercolani, again the cylindrical sporocysts produce Cercariæ with furcate tails like *C. furcata*, and the remarkable Bucephalus-larvæ are produced in branched tubular sporocysts.

The object of the present note is to indicate the existence of a hitherto unknown form of sporocyst, one specimen of which I observed recently swimming very actively in an aquarium containing a few water plants and fresh-water mollusks. In form and size it recalls the larger Cercariæ with forked tails, and contains a single tailless Cercaria or larval Distome. In accordance with its free life, the muscular system is much better developed than

usual, and the same is true of the water-vascular system. Of especial interest are tactile papillæ, which beset the surface, and which obviously enable the sporocyst to find the definitive host for its contained larva. These papillæ are somewhat more complicated than the similar structures described by Fischer from the neighborhood of the cirrus-pouch of *Opisthotrema cochleare* (Zeit. wiss. Zool. XL, 12). In a future paper I propose to give a full account of the structure of the sporocyst and its contained larva. It would be premature to attach any specific name to the Distome, as it may turn out to be a well-known form, but I am at present unable to offer any suggestion as to its "whence" or "whither." I examined the mollusks in the aquarium for other specimens in vain, and, in the hope of obtaining others for infection experiments, hardened and sectioned the only one I had secured.

Professor Leuckart, to whom I communicated the substance of the above, writes: "Your observation is certainly calculated to astonish helminthologists. I doubt whether the creature is really free-living, but believe that, in place of the Cercaria, it represents only the swarm-phase of the parasite. An entirely free-living sporocyst, without intestine, would hardly find the conditions necessary for a complete existence. It probably lives parasitically within a mollusk, and wanders out after development of the contained larva, in order to seek a suitable host for the latter. Perhaps it may attach itself to the host by the flat lobes of the forked tail, and then discharge the larva imprisoned within it."—*R. Ramsay Wright, University College, Toronto, Jan. 12, 1885.*

STRUCTURE OF ECHINODERMS.—C. F. Jickeli has a preliminary note in which he states that he has made experiments confirmatory of the doctrine of Carpenter as to the nervous system of Comatula. He finds that a single arm gives no response when the ambulacral groove is touched with a needle or stimulated by an electric current, but that the moment the needle touches the point at which the axial cord lies the arm is strongly flexed, and the pinnulæ more actively. A single cirrus when stimulated appears to be thrown into a tetanic condition. Many of the author's experiments are in exact agreement with those of Carpenter. After the removal of the visceral mass irritation of the capsule produces a synchronous contraction of all the arms. If a few drops of osmic or acetic acid are put in the water, the "torso" moves as actively as an uninjured animal.

The author describes the structure of the cirri, and the processes which pass from the "spongy organ" into them. The observations of P. H. Carpenter that nerve-branches pass into the dorsal and the ventral muscles is confirmed. A series of sections shows that the ambulacral nerve diminishes in extent as it approaches the intestine, and finally disappears. Attention is

drawn to the fact that Götte describes the epithelium of the so-called ambulacral groove of Comatula as being endodermal in origin.

A third nerve-center is described as being present in the connective tissue, and as forming a pentagonal cord around the mouth. The lateral cords are connected by branches with one another at the angles of the pentagon, and they extend along the water-vascular system; each of these cords gives off lateral branches at regular distances, and these innervate the water-vascular system, and the papillæ of the tentacles. Other well-developed branches are also given off to the ventral integument of the body, where they are lost in a fine nervous plexus. Ludwig's view of the glandular character of the tentacles appears to be incorrect. They have 3–4 sensory hairs and a centrally-placed slowly-moving flagellum. From these observations it would follow that the tentacular papillæ are complicated sensory organs.—*Journ. Royal Microscopical Society, Dec., 1884.*

Affinities of Onchidia.—R. Berg, after discussing the views as to the affinities of the Onchidia, which have been held by preceding writers, protests against the doctrine that they are nudibranchiate mollusks, and claims them as decidedly pulmonate; their nervous system does not differ essentially from that of the Pulmonata; it only differs in having the lowermost part more condensed and reduced, the opthalmophores are like those of the stylommatophorous Pulmonata, and the pedal glands have very similar relations, as has too the digestive system. It is true that the Onchidia are "opisthobranchiate," but so are Arion and Limax; in this group, at any rate, the position of the heart has no systematic significance. The kidney is very like that of the Pulmonata, and the difference between the sizes of the lung-cavity is to be explained as due to the largely cutaneous mode of respiration in the Onchidia. The most striking proofs of relationship are to be found in the structure of the generative system; the seminal duct has a position in the lateral wall of the body, such as has never yet been demonstrated in any Nudibranch, but only in the Pulmonata. The Onchidia are Pulmonata which have adapted themselves to an amphibiotic or marine mode of life.—*Journ. Royal Microscopical Society, Dec.*

Zoological Notes.—*Polyzoa.*—The Polyzoa of the *Challenger* Expedition have been described by Mr. Geo. Busk, who finds that out of 286 species of Cheilostomatous Polyzoa, no less than 180 are new. The Reteporæ alone have been raised from 31 to 60. In the North Pacific four species were procured from 3125 fathoms. Certain species have a great bathymetrical range. *Cribrilina monoceros*, one of the four taken in 3125 fathoms, was in the South Pacific taken in 1325 fathoms; from 69 fathoms near Kerguelen; from 55 in the South Atlantic, and from 35 in

the Australian region. As a rule, however, the species having the wider geographical distribution are those from the shallower depths. Another exception to this rule is the genus Catenicella, rich in species, and almost confined to shallow Australian seas.

Mollusca.—*Nature*, in reviewing Dr. R. Bergh's report upon the Nudibranchs collected by the *Challenger*, remarks that few shallow water dredgings were made during the cruise, and thus it is not strange that only twenty-five species were found. The majority of them are Phylliroidæ and Æolidiadæ, and are pelagic; some are littoral, as *Janclus australis*, of which a single specimen was taken in the Arafura sea. Another, *Cuthonella abyssicola*, was taken by the trawl in Farœ channel at 608 fathoms. Some new Tritoniadæ and Dorididæ are described, and among the latter the most interesting is *Bathydoris abyssorum*. The body of this species is semiglobular, as in the genus Kalinga of Alden and Hancock, and it resembles this genus also in having branchiæ composed of several separate branchial tufts, as well as in the presence of soft conical papillæ on the back. It has no frontal appendage, and a very slightly pronounced dorsal margin, and seems to connect the Dorididæ with the Tritoniadæ. The only specimen was taken in 2425 fathoms in the middle of the Pacific. The body of the living animal was gelatinous and transparent, the foot dark purple, the tentacles brown, and the gills and other external organs orange. One specimen only of the Onchidiadæ, *O. melanopneumon*, was taken in shallow water at Kandara, Fiji. Dr. Bergh believes these animals to have no relation to the Nudibranchs.——Mr. J. R. Davis (*Nature*, Jan. 1), assert that limpets have a settled home, for they occupy scars on the rock, often sunk to a considerable depth. He marked and watched specimens to prove this, and found that, though a marked limpet might move about three feet from its scar in any direction, in search of food, it always found its way back. A limpet always returns before the rising tide reaches it, and roosts with its snout pointing in the same direction. Mr. Davis asks what sense is used? The eyes of a limpet, mere sensitive cups, can at most distinguish different degrees of light intensity; the examples deprived of their tentacles found their way back, and repeated washing of the track with sea-water in order to destroy scent did not prevent the limpets' return.

Stelechopoda.—Dr. L. von Graff has described the Myzostomida of the *Challenger* collection. Myzostomes are small disk-like animals which were attached to crinoids, and their cysts have been found upon the stalks of fossil Pentacrini. Dr. von Graft requests any palæontologist having crinoids under his care to examine the specimens, and, if he should notice little pustules at the base of the pinnules, to communicate with him. Graff's class Stelechopoda embraces the Tardigrades, Linguatulids and Myzostomes. The forms before known were characterized by the

peculiar radial arrangement of the organs of the body, but among the sixty-seven species here described are many which are without this radial arrangement, while in Stelechopus not even the muscular septa and parapodal muscles are convergent. This fact strengthens Dr. von Graff's previous idea that the radial symmetry was an adaptive change due to fixation. Several forms are entirely without suckers, while in *M. calycotyle* the suckers are stalked. The Myzostomes are diœcious, but the sexes unlike. When inhabiting the same cyst the female is usually from fifty to a hundred times larger than the male.[1]

Crustacea.—Dr. P. P. C. Hoek found complemental males in nineteen out of the forty-one new species of Scalpellum gathered by the *Challenger* Expedition. Some of those complementary males do not show a division of the body into capitulum and peduncle; a second section still without such division has rudimentary valves; a third has valves, capitulum and peduncle. Darwin's "true ovaria" are believed to be pancreatic glands.

Birds.—Dr. W. Buller (Trans. N. Z. Institute, 1883) furnishes notes on some rare New Zealand birds. *Sceloglaux albifacies*, the laughing owl, has been found in deep fissures of the limestone rocks at Albury, near Timaru. Examples were procured by a process of smoking-out. In this species the male is the larger bird, and has a harsher cry than its mate. The four captured by Mr. Smith became quite tame, and in matters of food showed a decided preference for young rats, though they would eat mutton, beetles, lizards and mice. Their call on waking up at nightfall was "precisely the same as two men cooeying to each other from a distance." (The cry known as coo-ey is the call-note of Australasian settlers.) The rock-crannies in which they live by day and build their nests are dry, narrow at the entrance, and often five or six yards deep. They become almost naked while molting, and in this state two of Mr. Smith's birds were stung to death by a swarm of bees.——It appears that small birds such as the silver-eyes (Zosterops) and the English sparrow are in New Zealand often killed by adhesion to the viscid carpels of *Pisonia brunoniana* or *P. sinclairii.*

Pisces.—In a letter received by Professor Liversedge from Mr. Caldwell, the latter states that the eggs of Ceratodus measure about $2\frac{1}{2}^{mm}$ in diameter, and have the protoplasmic pole darker, as in the Batrachia. The egg is surrounded by a strong closely-investing gelatinous membrane about $3\frac{1}{2}^{mm}$ thick. The segmentation is complete. "Part of the blastopore remains open, and persists as anus. The stages up to hatching closely resemble those of Amblystoma. After hatching, the larva goes into the mud. It lies on its side like Pleuronectidæ among the Teleosteans, and the oldest stages I have reared still show no traces of external gills. The larval changes, I expect, will continue for many

[1] Mr. S. A. Miller has probably already characterized this order from fossil specimens.

weeks." Mr. Caldwell states that he will leave a large number of the larvæ in an aquarium at the station in Queensland, and will also bring a supply of eggs to Sydney to rear in the laboratory.—*Nature.*

EMBRYOLOGY.[1]

On the Translocation Forwards of the Rudiments of the Pelvic Fins in the Embryos of Physoclist Fishes.—The two great subdivisions into which the species of Teleost fishes are divisible, viz., the Physostomi and Physoclisti, stand to each other in the relation of the unspecialized and the specialized in respect to the evolution of the paired fins. The members of the group Physostomi tend to retain the pelvic limb more or less nearly in its primordial position throughout life, and no marked tendency towards the approximation of the rudiments of the anterior and the posterior limbs seems to be exhibited by the embryo, as may be seen upon studying the development of a form as typical of the group as the salmon or trout. Such retention of the primordial posterior position of the pelvic fins by the embryos of Physostomes supplements those other more unspecialized traits which they possess, viz., the open pneumatic duct, persistent throughout life, and the simpler or more primitive condition in later life of the *paraglenal* elements (coraco-scapular plate in the embryo), commonly differentiated in the adult into hyper-, meso- and hypocoracoid, in Gill's nomenclature, whereas in the Physoclisti the mesocoracoid is suppressed. The frequently persistent protopterygian condition of a portion of median dorsal fin-system, developed as a so-called adipose fin, is another embryonic character retained by many Physostomes.

While the foregoing characters are unquestionably of value as determining the relative position of the two groups under discussion, I would now call attention to some embryological phenomena which demonstrate beyond any doubt that the Physoclisti have descended from the Physostomi.

In the young larva of Lophius, or the angler, taken from the egg shortly before hatching, A. Agassiz[2] has shown that the pectoral and pelvic fin-folds arise, the latter behind the former and almost synchronously, as lobate diverticula of the epiblast, into which mesoblast has been thrust outwards, and with their bases nearly horizontal. In this relation of position as anterior and posterior paired outgrowths they develop just as do the rudiments of the paired fins of the Physostomous salmon embryo; but the two pairs of fins are much more nearly synchronous in making their appearance, and are much closer together. The figure of the youngest stage of the angler given by Agassiz shows that there are but four myotomes opposite the interval be-

[1] Edited by John A. Ryder, Smithsonian Institution, Washington, D. C.

[2] On the Young Stages of Osseous Fishes, Part III, 20 plates; Proc. Amer. Acad. Arts and Sciences, Vol. XVII, July, 1882 (Plates XVI, Figs. 2–5, and XVII, XVIII).

tween the pelvic and pectoral fin-folds, whereas in the young salmon, relatively somewhat older, there are at least sixteen myotomes opposite the interval between the pelvic and pectoral fin-folds. This fact would seem to indicate that the tendency to shift the pelvic limb forwards must have commenced to manifest itself far back in the ancestral history of Lophius.

The sudden translocation of the pelvic fin of Lophius, which now follows in the next stage figured by Agassiz, gives us a clear conception of how the jugular or thoracic position of the pelvic limbs of Physoclists has been brought about. It also clears away the difficulties which Haswell and Fürbringer have encountered in reconciling the condition of the nerve supply of such shifted fins with the theory of the origin of the paired limbs from continuous folds or serially homologous rudiments, as developed by Balfour and Dohrn. For, in the next stage, we find the base of the pelvic fin suddenly swung round, down and forward through an arc of nearly 90°, so as to carry the whole structure below the base of the pectoral. This shifting is then carried still further, so that the bases of the pelvic fins are finally situated below and in front of the insertion of the bases of the pectorals. The other equally singular and extraordinary embryonic changes undergone by Lophius we cannot discuss at present, but would refer the reader to the original memoir.

This remarkably sudden shifting of the pelvic fins of Lophius embryos, within a period of twenty-four hours, is a fine example of saltatory development, or of how a sudden developmental leap may be manifested, which does not very seriously involve adjacent structures. Embryonic development is, in fact, everywhere diverted from its archetypal mode, so to speak, by such interference with the primordial synchrony or primitive order in time and space of the appearance of different organs. It is the business of the philosophical morphologist to keep in mind the import of such phenomena, and to weigh their significance in the discussion of the evolution of organic forms.

The nerves, vessels, muscles and bones appertaining to the successive rays of the median fins are, as is well known, derived from embryonic metameres which are simply more developed or differentiated in the adult. The cartilaginous rays or *actinophores*[1] of the paired fins of the Elasmobranchs and the rays of the unpaired fins of Teleosts are known to sustain such a relation of homonomy to the primary metameres first indicated in the embryo, though in some types two, three or even five actinophores may stand in a derivative relation to such a single embryonic segment or somite. There is also much ground for the belief that in the paired fins of Teleosts it is possible to trace such a relation between the somites over which they originally arose and the actinosts or actinophores which constitute their axial skeletons,

[1] The most peripheral skeletal elements which afford support to the true fin-rays of the Lyrifera.

much as the Teleostean paired fins have been specialized and altered in the course of the history of the phylum.

If it is, therefore, found difficult to trace the nerve supply of the pelvic fins which have been thus shifted into a jugular or thoracic position to segments above them, or to reconcile their mode of innervation with the lateral-fold theory of their origin proposed by Balfour, the comparative anatomist who confines himself to the study of adult structures should not be surprised, for he can know nothing of the translocation of the whole fin-rudiment forward and downward unless he is acquainted with the process which brings this about. Neglecting this, he remains ignorant of what embryological investigation and investigators might do for him, though he will often criticise the conclusions of the latter upon the basis of his knowledge of adult structures, which, as in the case above instanced, would manifestly be insufficient to enable him to get at the truth. This interesting example of the value of embryological observations as the basis for deductions in scientific morphology, reminds the writer of what Bruch[1] has said, to the effect that, "In the kingdom of nature, as in history, all that has *become* is to be understood only through its *becoming*."

Lophius is an extreme type, yet other equally interesting forms have been described, traced and figured by Mr. Agassiz; for example, Gadus does not bud out the rudiments of its pelvic fins so early as Lophius, though another form, Mallotus (= Onos), seems to bud out the pelvic limb nearly as soon as the embryo angler. Gadus is evidently intermediate.—*John A. Ryder.*

Development of the Viviparous Edible Oyster.[2]—In this essay, the text being duplicated in Dutch and French, Dr. Horst brings together about all the information of value which has been acquired by his predecessors and contemporaries, and also gives an account of his own investigations, especially those which relate to the development of the shell-gland and gastrula, which he had, however, first published two years ago. The gastrula is the first to be invaginated; this is followed by the invagination of the shell-gland on nearly the opposite side of the blastula.[3] The mouth is formed at the time of invagination of the gastrula; the anus is formed later, and is broken through at the end of the gastrular pouch of endoblast, which blends with the ectoblast, which also becomes perforated where the two blend. The mantle cavity is formed by the appearance of a space between the posterior mar-

[1] "Alles Gewordene, im Reiche der Natur, wie in der Geschichte ist nur durch sein Werden zu begreifen, und die Entwickelungsgeschichte ist in diesem Sinn für den Naturforscher vollkommen dasselbe, was die Weltgeschichte für die Menschheit" (Wirbeltheorie des Schädels).

[2] De ontwikkelingsgeschiedenis van de œster (*Ostrea edulis*), door Dr. R. Horst, and Embryogénie de l'Huître (*Ostrea edulis*, L.), par le Dr. Horst, Tijdschr. der Ned. Dierk. Vereen. Suppl., 1884, pp. 1–63, 1 pl., Leiden.

[3] In this, his observations are not in agreement with Brooks' observations on *O. virginica*, in which that author finds the invagination which leads to the development of the shell-gland to coincide with the blastopore.

gins of the larval valves, lined with ectoblast (mantle), into which the vent opens. The anterior adductor muscle degenerates after fixation, when its function is assumed by the posterior adductor, which develops after the former. The cephalic ganglion originates from an epiblastic thickening situated in the center of the trochal disk or velum. The larval shell is homogeneous; but at the hinge there are two small teeth separated by an interval from each other.

The earlier stages are copied from Möbius, who incorrectly represents the nucleolus of the ripe egg as being spheroidal, whereas the writer has shown it to be a double body in the ova of the three species, including *O. edulis*, investigated by him.[1]

Dr. Horst's more recent investigations upon the early growth and fixation of the fry or veliger stage of *O. edulis* and its metamorphosis into the "spat" are of great and significant interest. Carrying out more fully a suggestion made by the writer in 1881, Dr. Horst used a wooden frame, into which could be fixed a large number of glass slides, such as are used by microscopists. This frame, with its contained slides, some of which were coated with hydraulic cement, was immersed for a period of seventy-two hours in waters where free-swimming oyster larvæ were known to exist, at the end of which time spat was found adhering to the slides, measuring 0.24^{mm} in height ($\frac{1}{104}$ of an inch). After fixation, which seems to occur in the same way as in the American species, the permanent shell is formed or built up by the mantle beyond the margins of the valves of the fry, a homogeneous membrane, subdivided internally into polygonal spaces or areas, being first laid down by the mantle border. In these prismatic areas of the periostracum, calcification occurs by the deposit of calcic carbonate, and the shell is thus moulded upon the membranous matrix of conchioline. Attachment and growth of the young edible oyster, according to Horst, is very similar to that of the American species, as described by the writer (Bull. U. S. Fish Commission, ii, 1882, p. 383). The outgrowth of the first branchiæ as two series of distinct ciliated processes projecting into the mantle cavity of the spat is interesting as showing that the more primitive condition of the lamellibranchiate gill was much simpler than in the existing adult oyster.

PHYSIOLOGY.[2]

THE TEMPERATURE SENSE.—By an ingenious device Dr. Politzer has been able to make what are probably exact determinations of the sensitiveness to heat of the skin in different parts of the body. The rounded bottom of a small platinum cylinder was heated to a constant temperature by means of benzole spray. The cylinder was raised or lowered by a rack and pinion arrangement and the distance between cylinder and skin was determined

[1] Bull. U. S. Fish Commission, II, 1882, p. 213.

[2] This department is edited by Professor HENRY SEWALL, of Ann Arbor, Mich.

at which the radiant heat could just be perceived. The relative sensitiveness of the skin in different parts is calculated as being inversely as the squares of the distances measured. The following table indicates the relative sensitiveness to heat of different parts of the skin, the sensitiveness of the palmar surface of the third phalanx of the index finger being considered as 100:

Finger.	Dors. Hand.	Back.	Forearm.	Palm.	Calf.
100	204	204	270	294	314

It follows from the observations made that, "1. The relative sensitiveness to heat in different parts of the body is not the same in different individuals. 2. It differs much less in different parts of the same individuals than the sensitiveness to pressure or power of localization, the greatest difference for heat being as three to one; while for pressure it is at least as five to one, and for localization as sixty to one. 3. The parts in which the other cutaneous senses are most acute are not the same as those in which there is greatest sensitiveness to heat. 4. Of the parts examined, the tip of the index finger is the least sensitive; in the other parts where the sense of locality is from five to thirty times as dull, the thermal sense is from two to three times as acute. 5. The thermal sensitiveness bears no definite relation to the thickness of the epidermis." On the contrary the time necessary for an increase of temperature to be perceived depends directly upon the thickness of the epidermis which is heated (*Jl. Physiology*, Vol. v, p. 143).

Drs. Lombard and Walton seek to explain temperature sensations as the outcome of mechanical stimulation of sensory nerves whose endings are submitted to strain due to unequal expansion of the two layers of the skin when its temperature is changed. These authors find that various fresh animal tissues, as tendon, expand when warmed, and contract when cooled; others, as elastic tissue, contract when warmed and expand on cooling; the epidermis, separated by maceration, is scarcely affected by temperature, while the skin as a whole acts like elastic tissue. It appears, then, that tensions between dermis and epidermis would be brought about by changing the temperature of the skin. In the experiments referred to the temperature was varied between 0° and 63°C.—*Centralbl. f. Med. Wiss., 1883, No. 32.*

Rhythmic Contraction of the Capillaries in Man.—Local and obscurely automatic rhythmic contraction of the bloodvessels is an established fact. Wharton Jones found that the veins in the bat's wing underwent rhythmic expansions and contractions even after there was good reason to suppose that the influence of extrinsic nerve centers was excluded. Such venous contractility must be a very important factor in the circulation of the blood. An artificial current of blood forced under constant pressure through the vessels of an excised, but living muscle, undergoes alternate acceleration and diminution which can only be explained by changes in the caliber of the muscular vessels.

Dr. Lauder Brunton describes a simple experiment, but not one very easy to verify, by means of which rhythmical contraction and dilatation of the capillaries in man may be demonstrated. If the finger-nail be drawn once or twice up and down the middle of the forehead a red streak remains which may persist many minutes. This streak undergoes variations in width and brightness, some of which correspond to the heart-beat, others to the movements of respiration, and still another series have a slower rhythm of some twenty seconds interval; these last changes probably have their origin in purely local contractions of the capillary walls.—*Jl. Physiology, Vol. v, p. 14.*

THE PISTON RECORDER. — Schäfer describes a very simple device for registering graphically the variations in volume of a frog's heart, which may find quite general application. The organ whose changes of volume are to be measured is inclosed in a vessel filled with fluid which communicates with a horizontal glass tube of 3–4 ^{mm} diameter containing oil. A disk of platinum fits closely in the tube and is in contact with the oil column whose movements it follows perfectly without allowing the escape of oil round its rim. An aluminium rod of proper length, bearing a writing point at one end, is fastened to the center of the platinum disk, and the piston rod passing through a hole in a cap at the end of the glass tube is kept moving in the center of the latter. —*Jl. Physiology, Vol. v, p. 130.*

THE ORIGIN OF FIBRIN FORMED IN THE COAGULATION OF BLOOD. —Research upon the cause of blood clotting has been rendered very difficult because of rapidity of the process of coagulation in the blood of most animals. Dr. Howell has discovered that the blood of the terrapin clots very slowly and offers unequaled advantages for the study of its chemical changes. A sample of this blood left in a refrigerator at 15° to 20° C. was found still perfectly fluid at the end of a week; the corpuscles had completely settled leaving a deep layer of clear plasma above. A very careful series of experiments led the author to uphold that view of coagulation according to which the process is due to the transformation of a single chemical body, fibrinogen, which exists pre-formed in the blood plasma, into fibrin under the influence of fibrin-ferment, which is a product of the dissolution of white blood corpuscles. —*Stud. Biol. Lab. Johns Hopkins Univ., Vol. iii, p. 63.*

VOLUNTARY ACCELERATION OF THE HEART-BEAT IN MAN.— There are on record a number of well-authenticated cases in which the rate of heart-beat seems to have been under easy control of the will. As is well known, the pulse rate and character is normally profoundly influenced by the emotions, and there is little doubt that in most of the cases recorded the alteration in heart rhythm was brought about indirectly through the excitement of the appropriate psychical condition. In fact, simple concentration of the attention on the heart movement is sufficient, in most

cases, to alter the regularity or rate of its rhythm, and it is probably impossible for one to make an accurate estimate of his own pulse. But there are several instances in which the connection does not seem to have been so clear. Tüke investigated the case of an old man who at will could increase his heart rhythm by twenty beats per minute. A Lieut. Townsend could restrain respiration and heart beat until he fell into a death-like condition and the body began to grow cold. Professor Tarchanoff reports a series of experiments carried out on a student who could voluntarily hasten his heart-beat from about 90 to 120 beats per minute. The patient declared that this acceleration was not preceded by any special emotion, and mere thinking of the condition would not produce it, but that a direct and fatiguing effort of the will was necessary to cause the quickening. Comparative measurements showed that during the acceleration there was no constant alteration of the respiration, but that the blood pressure uniformly rose with the heart beat.—*Pflüger's Archiv. Bd., 35, p. 109.*

PSYCHOLOGY.

INTELLIGENCE OF A SETTER DOG.—In the winter of 1880 I purchased in the East a dog puppy out of a purely bred English Gordon setter bitch, by the well known prize-winning Irish water spaniel, Bramton Barney.

He was the only puppy in the litter and no other puppies came from the same cross, for the reason that the bitch died soon after, and bringing the puppy here he was named Barney, and keeping him in the office where there were several persons employed, his exceeding good nature was courted and his naturally pleasing (aside from his determination), yet nervous disposition was encouraged.

After a little training Barney took to retrieving, but his more noticeable traits was the working up of some mischievous act of his, which, though puppy-like, would at times be so unlike the ordinary as to appear to the observer as original.

In the spring following, when but about six months old, he retrieved his first duck from water, and this one being a wounded ruddy duck made the young "dropper" labor hard to make good the catch and bring the bird to me, as it was yet alive.

From this time on there seemed no difficulty in getting him to go for a wounded or dead bird at any time, but owing to his exceedingly stubborn nature he was very hard to govern in such manner that he would perform the service as work and not as play. At all times he was making new surprises, but only minor ones until the coming fall, when he was about one year old. At this time I was hunting in a marsh near here and had walked out into the water to a depth of about two feet and some one hundred yards from shore, breaking the ice which, by the way, was not very thick. Barney without a whine followed after me and without

noise remained by my side until the first duck was dropped, which was in time nearly half an hour, and the duck fell in the open water seventy-five yards away.

The ice was not quite strong enough to hold up the dog and in his struggles to get through about fifty yards of the ice before reaching the open water he had a very tedious time of it. At last he reached the duck and taking it in his mouth, swam first towards the broken ice which he had made and then turning to one side broke a new path away, but not in the direction of where I was standing, but in a direct line for the shore, deviating only as forced to evade a too heavy growth of rushes. Arriving upon shore he placed the duck alongside of some ammunition sacks I had left near a log, and upon the log and overcoat, thinking that perhaps this would have a tendency to drive the ducks and other birds coming up near the bank to shear off towards my blind in the rushes. His desire to get to this log in as short a way as possible was evident, for as soon as he dropped his duck, he at once pulled the coat off the log, but to the east side and, lying down upon it kept only his head exposed to the piercing north-west wind as it struck the right side of the log which lay almost parallel with the points of the compass north and south. This he continued during my shooting for the forenoon, only changing when I shot a duck, when he would at once run as rapidly as he could to the channel he had made—swim out to where the duck had dropped, pick it up and return to place it with the first and then to again resume his position behind the log, with his head above on the lookout.

Even as he grew in years his good nature of puppyhood did not forsake him; in the kennel he was the popular dog. All the female dogs and puppies liked him and it seemed to him the greatest pleasure when a puppy was being hurt to rush up and chase the abuser away. He was also given to particular fancies. Some men he did not like, while others instead he was particularly fond of.

As a companion he was with me going down the Arkansas river, in the winter and spring of 1882; to Labrador, in the summer of the same year and many other nearly similar trips. Different from most dogs I have observed; while he at times was as jealous as any, at others he was quite indifferent. His human acquaintances named him the " noble dog," and this must have been a like opinion among his canine friends.

In the kennel where he was kept for a considerable time were quite a number of dogs and bitches, and scarcely at any time but that there were a number of puppies there also. In this kennel was one highly bred pointer of large size, a powerful animal, but with a very miserable disposition.

It was an almost continuous occurrence for Barney to play with one or more of the puppies, permitting them to pull his ears, tail and other parts of the body; sometimes when three or four of

them would take position at opposite points, and pull with all their strength, he did not growl or get vexed, for at such times he was in his element and enjoyed it the more when he could jump high into the air to frighten his young friends.

The pointer instead would not permit a puppy to approach him, in fact had so bitten a couple that they had died.

From some cause this pointer, Wad, and Barney were the worst of enemies, and in consequence there were many battles, and the pointer being the more powerful would have ruined his foe, were it not for the support of one of the bitches—an Irish water spaniel.

This bitch, Frank, would rush up at once upon seeing Barney thrown under his adversary and catching the pointer by one of his hind legs, start off with a sudden jerk; the result would be that Barney would once more come to his feet and in the end because of his being shaggy would get the best in the fight with the vicious, yet plucky pointer.

In all these fights should Barney get bitten so that blood would be shown there seemed to be a perfect panic amongst the bitches and puppies.

One instance in particular is noticeable. Returning to my office one afternoon I observed many people running towards the kennel, which was in the rear of the office.

A workman who had been engaged in the kennel was hurriedly running up the street to me. He said that Barney, and the pointer were having a big fight, and that Barney, assisted by the bitches, was eating up the pointer.

Upon arriving within the kennel my greatest surprise was to see the grown bitches chasing Wad—whose coat naturally pure white was now covered with blood—around the yard as rapidly as could be, Frank the more savage of the number; while Barney with a lot of puppies around him was assisted by them in licking his wounds. The workman, who at the time the fight began was at work on the south side of the kennel in cleaning out a bathing tank, informed me that Wad was lying in the shade of the high fence at that side and that Barney went over to him and taking hold of Wad's ear led him away from this shady place to the north side of the kennel where the sun shone very hot. Here he left him and at once went back to the shady place to lie down, from which he had so unceremoniously taken Wad.

The workman, who was a stranger and had been at work there only a few days, attempted to drive Barney away, but instead Barney growled and would not leave—showing plainly his disposition to attack the workman.

Wad had followed Barney, but did not offer fight until after Barney's growling, when he at once rushed upon him. In a few moments Barney was the "under dog" in the fight and continued so until Frank as usual came to the rescue. This she did, sev-

eral times catching Wad by one hind leg and giving Barney a chance to get up again.

Several witnesses who climbed up and saw the fight over the high board fence corroborated this part of the statement by the workman.

When I saw Barney after the fight he was lying in the chosen place he had driven Wad from, with all the puppies and bitches around him.—*To be continued.*

ANTHROPOLOGY.[1]

THE PROTO-HELVETIANS (*continued*).—The age of bronze shows a marked advance on preceding ages. The villages of that period were more extensive, the dwellings, as is shown by the planks and main timbers which still exist, larger. In each village there appears to have been an open place where work was undertaken that could not well be done indoors. The discovery on the sites of the lacustrine villages of Neuchatel and Bienne, of molds, crucibles, metal broken for the melting pot, damaged and half-repaired tools and weapons, is sufficient to disprove the theory that the workshops were on the land. There is reason to believe that the stations of the bronze age, unlike those of the stone age, were more or less contemporaneous. Except in unimportant details, the remains of that period hitherto brought to light possess the same general features, and none of the villages appears to have outlived the others.

Some of the swords of the bronze age are elegantly shaped and exquisitely worked. They were probably worn by the chiefs, and served rather as badges of authority than as weapons of offense. The form of them is that of a willow leaf, and their length varies from seventeen to twenty-three inches. The blades are generally ornamented with several parallel bands and fastened to the hilt with rivets. One of the finest specimens found at Lorcas, in addition to the bands, is ornamented with a series of punctured lines, and the hilt, which is bossed in the center, has a short cross-guard. The total length of the blade is 23.89 inches (sixty-seven centimeters), the hilt measures only eight centimeters. None of the hilts are much larger, and judging by the size of their weapons, the lake-dwellers must have had remarkably small hands.

The hilt of a sword found at Mœrigen appears to have been ornamented with ivory or amber, and its blade of cast bronze is inlaid with thin plates of iron, the metal, which is now the commonest of all, being in that age the most precious. The blades of all these swords are straight and pointed, and designed rather for thrusting than for cutting.

But the gem of Dr. Gross's collection is a steel sword found at Corcelettes. The fact that it is steel has been proved by analy-

[1] Edited by Prof. OTIS T. MASON, National Museum, Washington, D. C.

sis, and the specimen is unique among lacustrine finds. The blade, which has suffered somewhat by fire, is 25.58 inches long, straight and pointed, and the waved lines with which it is embellished are evidently the work of some pre-historic engraver. Who were the forgers of this weapon is a question Dr. Gross discusses at some length and, having regard to the undoubted skill of the Lacustrians as metal workers and to other circumstances, he leans decidedly to the opinion that it was wrought by themselves; yet seeing that no other arm of the same material has been found elsewhere, the correctness of this conclusion is perhaps open to doubt. Among the objects brought to light by the labors of Dr. Gross are bronze daggers, highly ornamented hatchets, chisels, gouges, knives, hammers, anvils, needles, tools for net-making, fishing-tackle, buttons, chains, spoons, spearheads, arrow-points and rings, bracelets and other ornaments in great variety. Strange to say, saws, though they seem to have abounded in the stone age, are rarely found among the vestiges of the age of bronze. The total finds of them in the Swiss lakes do not exceed half a dozen, of which two are in the collection of Dr. Gross. One was found at Mœrigen, the other at Auvernier, and both appear to have been used as frame saws. Another interesting find was that of a distaff at Lorcas (a stone age station) and a bundle of linen yarn, which, if it were not slightly carbonized, might be passed off as having been spun yesterday. No remains of looms have been found, but the discovery of linen tissues in great variety proves that the Proto-Helvetians were adepts both in weaving and spinning. They were also skilled mat, net and basket makers. It might be going too far to affirm that the lake-dwellers wore shirts and employed laundresses, but it is a fact that there have been found, at Mœrigen, bronze studs exactly like the studs which now adorn the fronts of gentlemen's shirts, and double buttons in no way distinguishable from the *solitaires* used for fastening wristbands. Ornaments of gold are not often met with in the ruins of lacustrine villages; nevertheless, two plates of the precious metal, embellished with parallel lines, a double and a single spiral, and a twisted fillet, have been found at Mœrigen and Auvernier. The objects appear to have been used as collars, or, possibly, as badges of princely rank. The single spiral bears a striking resemblance to a spiral found by Dr. Schliemann in the ruins of Troy. Until the discovery, eleven years ago, of a bronze bit at Mœrigen, it was not suspected that the Proto-Helvetians added horsemanship to their other accomplishments, and even for some time afterwards, the find was looked upon as the product of a later age, which had found its way into the lake by accident. But the subsequent finding at Mœrigen, Corcelettes, and elsewhere, of bits, broken and entire, a chariot wheel and bones and skeletons of horses, put an end to all doubts on the subject. Some of the bits are remarkable speci-

mens of metallurgic art. One of them is a sample of the type still in common use, both in England and on the continent. The mouth-piece is jointed in the middle and twisted, the cheeks are furnished with "dees" for holding bridle and curb-chain; and in shape and fashion the Proto-Helvetian bit differs hardly at all from the "snaffle" of English grooms and harness-makers. But it is much smaller (nine centimeters, 3 50 in. long.) than the modern bit, a fact which, together with the smallness of all the equine bones that have come to light, points to the conclusion that the horses of the bronze age were little, if any, larger than Exmoor ponies.

Professor Virchow, to whom Dr. Gross has submitted the skulls found by him at Auvernier, declares that the brain capacity of the lake-men was equal to that of the men of our own time. Their conformation, their cerebral volume, the peculiarities of their sutures, place them on an equality with the highest type of Aryan skulls. That people so richly gifted by nature should have succeeded so remarkably in the struggle for existence, affords no grounds for surprise. There was nothing in common between the lacustrine communities and the savage tribes whom a fatal law condemns to extinction so soon as they come under the influence of a civilization higher than their own. The lake-dwellers possessed a singular aptitude for progress, a rare capacity for adapting themselves to their environment, and making the most of their advantages.

The skulls examined by Dr. Virchow are doubtless those of individuals who fell into the water by accident, possibly at the time of the great fires in which nearly all the villages of the bronze age seem to have perished; for the discovery at Auvernier of a place of sepulture, shows that the lake-dwellers disposed of their dead by laying them in the ground. This cemetery contained the bones of about twenty individuals, and the presence among them of stone and bronze articles, their positions on the lake shore, opposite a range of piles, leaves no doubt that the remains are of lacustrian origin. The appearance of the ground denotes the existence of many other tombs; but the cost of exploring them has hitherto hindered the making of further explorations.

As touching the antiquity of the lake-dwellings of Proto-Helvetia, there is very little to be said. No medals, coins, or other relics, whereby the date of their erection can even be approximately determined, have been found. It may, however, with certainty be inferred, from the absence of anything Roman, that the lacustrian vanished from the scene before the appearance in Central Europe of the legions of the eternal city. According to the calculations of Von Sacken, moreover, the Necropolis of Hall stadt, which is admittedly more modern than the lacustrian stations, dates from about 500 A. C., and as there is good reason to believe that several centuries elapsed between the destruction of

the lake-dwellings, and the making of the Necropolis, the former event must have come to pass 800 to 1000 years before the Christian era. The duration of the ages of stone, copper and bronze, is a matter of pure conjecture. All that can be regarded as certain, is that it was very long. In the opinion of Dr. Gross, and of other erudite Swiss antiquaries, several series of centuries —perhaps twenty or thirty—must have elapsed between the time when the first piles were driven into the beds of the Swiss lakes, and the time when lacustrine civilization reached its highest development. We shall probably not be far out, then, if we assign to the oldest of the lake-dwellings an antiquity of not less than six thousand years.—*Contemporary Review, July, 1884.*

Western Tribal and Local Names.—Recent investigations of a linguistic purport on the Western States and Territories have yielded many interesting results, which may be fully relied on, because they were made and verified on the spot. Of *tribal names* we mention the following:

Bidai, a tribe in Southern Texas, of unknown affinity. The Caddo term bídai means *brushwood, thicket.*

Kichai, a tribe affiliated to the Wichita tribe; from the Wichita term kítsa, *water.* The Wichita Indians call a Kichai Indian, Kiétsash kuétsa, the Red river of Louisiana: Kitchka.

The *Caddo Indians* once were in the habit of wearing nose-rings, and are still called by other tribes "Pierced-Noses." The Káyowē style them Mōn-sépti, the Comanches Nasomoní'hta; "ring-nosed." They call themselves Assínai, which is the name of a populous tribe once seen in the center of Texas, by C. de la Salle (about 1683).

The *Cheyenne people* is called Sie-nawó nē and Páka-nawo nē[1] by the Còmanches; the first name: "striped feathers" refers to a headdress (siya *feather*), the other: "painted arrows" is derived from pák *arrow*, nábor "striped." The Káyowē name for that people, 'Ahiadl, is said to refer to their homes near cottonwood trees.

The *Apaches* of Arizona are called by the Comanches Hútashi or with the full form: Hûtâṣhi náp: *moccasins turned up at the toes.* Né ura'htó hútashi náp signifies: "I wear moccasins turned up," and a "pug-nose" is called múi tár;

Among the local names we point out the following:

Mobitēe, a rising town in the Panhandle of Texas, is called so from the Comanche term: móbitai, *walnut.* Several creeks and rivers in the vicinity are called by the same name.

Abilene, a town and railroad station of Northwestern Texas: from avelino, the Mexican name of the peccary or musk-hog, frequent in some portions of Texas and old Mexico.

Ozark, the name of this ridge is of French origin, and a muti-

[1] Nē, or ném is the Còmanche term for *people.*

lation of *bois aux arcs*, "wood for bows." The species of trees is the osage orange, used for bows and for making hedges; when cut green the wood never shrinks in seasoning.

Skullyville, name of a settlement in Arkansas, and of another in the Chá'hta Nation, Indian Territory. Probably derived from the French provisional term *escalin*, Spanish *escalino*, a coin twelve cents and a half in value. It is derived from the English *shilling*, and has passed into the Chá'hta language in the form: iskúla.

Prairiedanne, village in Arkansas: corrupted from French: *Prairie dinde* (d'Inde, coq d'Inde) or "turkey prairie."

Sangamon river, Illinois; a corruption of Saint Germain river.

Chilocco, name of an Indian training school in northern part of Indian Territory, near Arkansas city. Named after a streamlet in the vicinity, and representing the Creek term tchí-'láko, *horse* ("large deer").

Wolf river is the name generally given by Indians of the Indian Territory to the North fork of the Canadian, near which Fort Reno is built. The Comanches call it, and the fort also, Ìssa húnubi (ìssa, *wolf*, húnub'h, *river*).—*A. S. Gatschet.*

THE HISTORY OF RELIGION.—As now employed, the word religion may be taken to include all human beliefs and actions with reference to the spirit world. Of course, in employing it, we shall be sometimes talking of creeds, again of conduct, a third time of the organization of society into clergy and laity, and finally of the apparatus employed in all so-called religious actions. For the purpose of collecting and classifying all accessible information regarding the subjects above-named, excluding controversy about dogmas, M. Guimet has established the Musée Guimet at Lyons, and founded the Revue de l'Histoire des Religions, under the supervision of M. Jean Réville. The journal is of the highest scientific value, and proves its rights to a place in literature by closing its ninth volume, in its fifth year.

The contents of this volume, in brief, are as follows:

The Pratimoksha Sûtra, from the Thibetan. M. W. Rockhill.
The Ballad of Lenore in Greece. J. Psichari.
Sacrifices of Carthage at the persecution of Decius. M. Massebieau.
Review of Müller's "Greek Mythology." M. Reville.
The great solar Goddess, Ama-Terasow Oho-kami. De Rosny.
Belief in future life among the Jews. E. Montet.
The Myth of Osiris. J. Lieblein.

A great portion of the volume is devoted to reviews and Bibliography.

MICROSCOPY.[1]

THE BRAINS OF URODELA.—The following method of preparation is extracted from Professor H. F. Osborn's papers[2] on the brains of American Urodela, and from a letter in which the details are more fully given.

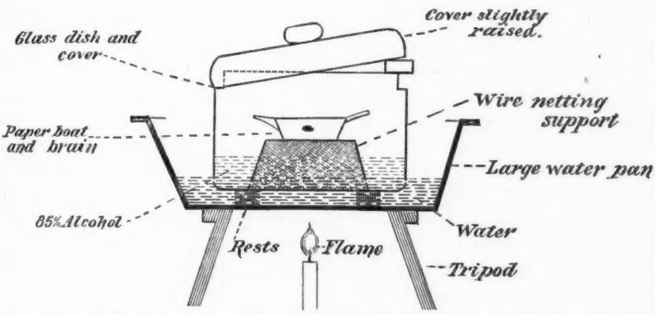
[1] Edited by Dr. C. O. WHITMAN, Mus. Comparative Zoology, Cambridge, Mass.
[2] Proc. Acad. Nat. Sc. of Philadelphia, 1883, p. 178, and 1884, p. 262.

"Before hardening the brains were inflated with Müller's fluid, so as to preserve the natural proportion of the cavities. After treatment with alcohol, they were placed for a week in dilute carmine. Calberla's egg-mass was employed as before, except that *the ventricles were injected with the mass before hardening.* The delicate parts of the brain-roof were thus retained. It appears now that celloidin may be used for this purpose to equal, if not to greater advantage in results, and with considerable economy of time. The sections were cut in absolute alcohol, were then floated upon a slide in consecutive order, from twenty to fifty at a time, and were covered with a delicate slip of blotting paper during treatment with oil of cloves."

Imbedding.—1. The egg-mass was prepared by shaking the white and yolk of egg together, with three drops of glycerine to each egg, and then well filtered through coarse cloth.

2. The bath is then prepared as follows:

a. Outside is a large water pan for boiling with the Bunsen burner, &c.



b. Inside this, supported on rests to prevent jarring, is a covered glass dish, filled to about one inch in depth with eighty-five per cent alcohol.

c. Within the glass dish is placed a piece of coarse wire netting which supports the imbedding box, raising it above the alcohol.

3. The box, made of paper in the usual way, and one-fourth filled with the imbedding mass, is kept in the bath until the mass is hardened enough to support the brain. The brain is next placed on the hardened stratum and covered with the fresh mass. The second stratum is hardened just enough to hold the brain in place, and then a third is added, filling the box.

4. The whole mass must now be allowed to harden through and through, requiring about fifteen minutes.

5. The hardening is completed by passing the box through three grades of alcohol—eighty, ninety and a hundred per cent, allowing it to remain twenty-four hours in each.

When the mass becomes nearly white and ceases to discolor the alcohol, it is ready for cutting.

SEMPER'S METHOD OF MAKING DRIED PREPARATIONS.—Semper's method, published in the Sitzungsber. d. phys.-med. Ges., Würzburg, 1880, and in the Zoolog. Jahresbericht for 1880, has been redescribed in detail by Dr. Sharp.[1]

1. Place the object in a weak solution of chromic acid (¼–1 per cent), six to twenty-four hours, according to its size and nature. For small animals, such as annelids, gastropods, frogs, mice, &c., six to eight hours are sufficient.

2. Transfer to a large quantity of clean water, which must be often renewed until the acid has been so far withdrawn that the water remains uncolored by it. This part of the process may be much shortened by allowing a current of water to flow through the vessel. The usual time is from ten to twenty hours.

3. Treat with thirty to forty per cent alcohol ten to twenty-four hours, with sixty to seventy per cent alcohol two or three days (with larger objects a week), with ninety per cent alcohol two or three days or more, and finally with absolute alcohol.[2]

4. Transfer to turpentine and leave it until it becomes thoroughly saturated (two to three days). With large objects it is best to change the turpentine once.

5. Place the preparation in the air, in order to evaporate the turpentine, protecting it carefully from dust.

The preparation soon becomes white, resembling the whitest kid. It is light, stiff and, on account of the resin contained, perfectly insect-proof.

If hollow organs (stomach, bladders, lungs, &c.) are prepared, they may be inflated with air after they have remained a short time in turpentine, by so doing much space, and consequently much alcohol, are saved.

Professor Semper keeps his preparations in dust-proof, glass boxes, in which they can be seen from both sides.

To the five steps of the process a sixth, discovered by Semper a few years ago, is given by Dr. Sharp. It consists in placing the prepared object in a solution of glycerine and sugar, which brings back almost entirely the original color in many cases.

RABL'S METHODS OF STUDYING KARYOKINETIC FIGURES.[3]—*Material.*—The skin and kidney of Proteus and the epithelium of the mouth of salamander larvæ. The epithelium is the more favorable object, as the very large nuclei can be examined in sur-

[1] Proc. Acad. Nat. Sci. Philad., 1884, pp. 24–27.

[2] The treatment with absolute alcohol is the most critical part of the whole process. *Absolutely* every particle of the water must be removed; for any tissue in which it remains will become spotted and eventually spoil. Dr. Sharp always takes the precaution of changing the absolute alcohol once or twice, and leaves the object in it three to seven days.

[3] Morph. Jahrb., x, H. 2, pp. 215–219, 1884.

face preparations. The achromatic spindles are seen to best advantage in the renal tissue.

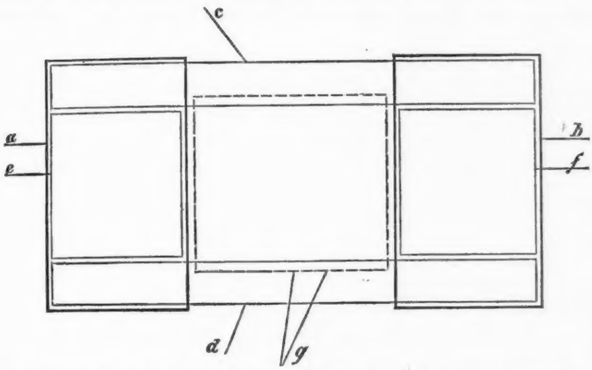
Preparation.—*a.* Place small fresh pieces of the object in *chrom-formic acid* (200 g. of a one-third per cent solution of chromic + four to five drops of strong formic acid) twelve to twenty-four hours.

b. Wash thoroughly and harden slowly, first twenty-four to thirty-six hours in sixty to seventy per cent alcohol, then in absolute alcohol.[1]

c. Stain in either of the three following ways:

1. *Grenacher's hæmatoxylin* (strongly diluted with distilled water) twenty-four hours, followed, after washing, with acidulated alcohol (few drops of HCl.).

2. *Pfitzner's safranin* two to four hours, followed by absolute alcohol, in which the object is left until no visible cloud of color



remains upon turning it over (generally about two minutes), clove oil a few minutes and dammar.

3. Double-stain with hæmatoxylin and safranin; stain very feebly with the hæmatoxylin; wash and treat with acidulated alcohol, and then stain with safranin as in number 2.

Examination.—High powers are required in the study of the mounted preparation, either the homogeneous immersion $\frac{1}{18}$ of Zeiss, with Abbe's condenser, or that of Hartnack, No. III, $\frac{1}{24}$. Nachet's camera was employed in drawing.

It it well to work with green light, which can be obtained by inserting a green colored glass plate beneath the table of the microscope, as was first recommended by Engelmann.

The slide devised by Rabl enables one to examine a prepara-

[1] Instead of the chrom-formic acid a ⅓ per cent solution of *platinum chloride* may be used, the preparation otherwise remaining the same. Chrom-formic acid causes the chromatin filaments to swell somewhat, so that their longitudinal division generally becomes obliterated; while platinum chloride causes a slight shrinkage, which brings out very distinctly the division of the filaments as well as the chromatin-spherules of Pfitzner.

tion from both sides. It consists of four pieces of glass of the shape and size seen in the figure (*a b c d*), and a cover-glass, *g*, which serves as the object-bearer. The two glasses, *a* and *b*, are painted on one side with chloroform balsam, and then connected by means of *c* and *d*. The frame thus formed is completed by adding the pieces, *e* and *f*, between *c* and *d*. The frame is next turned over and the middle portions of the glass bars, *c* and *d*, painted with balsam; and a thin glass cover, *g*, placed so as to rest on the pointed sides of *c* and *d*. This glass (*g*) bears the object in dammar, which is covered by another very thin glass. The object, lying between two thin cover-glasses, can be viewed from both sides with the highest powers.

THE PREPARATION OF MEROBLASTIC OVA.—*A. Reptilian Ova.*[1] —1. The ova taken from the oviduct are opened in a dilute solution of osmic acid (one per cent) and then the white removed as far as possible.

2. The osmic acid is then turned off and a weak solution of chromic acid (⅓ per cent) added, twenty-four hours.

3. With a sharp, fine pair of scissors cut around the germinal area, just outside its margin; and after it has been completely encircled with the incision, float it carefully off from the body of the yolk.

4. The yolk and acid are next removed, and a copious supply of clean water added, which must be several times renewed.

5. Calberla's fluid (glycerine, water and absolute alcohol in equal parts) three hours.

6. Hardened in ninety per cent alcohol.

7. Stained in Böhm's *carmine acetate* twenty-four hours.

B. Teleostean Ova (T. fario).—1. Chromic acid (⅓ per cent) twenty-four hours.

2. Distilled water two hours. The egg-membrane expands, and may now be easily removed.

3. Washed in distilled water twelve hours.

4. Absolute alcohol, glycerine and aq. dest. in equal parts four hours.

5. Absolute alcohol.

6. Böhm's carmine acetate one to two days.

7. Mixture of water (fifty vols.), glycerine (fifty vols) and muriatic acid (a half vol.), for a few minutes.

8. Washed in water, four to five hours.

9. Absolute alcohol twelve hours, preparatory to imbedding in paraffine.

BÖHM'S CARMINE ACETATE.—1. Carmine (four grms.) pulverized in 200 grms. water.

2. Ammonia added by drops until the solution becomes cherry-red (the carmine should now be fully dissolved).

[1] Kupffer. His and Braune. Archiv. Anat. Abth., 1882, p. 4.

3. Acetic acid slowly added until the cherry-red color becomes brick-red. The addition of acetic acid should be accompanied with stirring, and should cease the moment the change in color is effected.

4. Filter until no trace of a precipitate remains.

If the color is not sufficiently deep, a few drops of ammonia should be added before filtering, and the solution left in an open vessel until the alkali has volatilized.

Objects may be left for twenty-four hours or more in this fluid. The deep stain should be partially removed by immersion in a mixture of water (fifty vols.), glycerine (fifty vols.), and muriatic acid (a half vol.), for a few minutes. The karyokinetic figures are thus brought out with great distinctness.

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SCIENTIFIC NEWS.

— The Entomologische Nachrichten, founded by Dr. Katter at Putbus, is now edited by Dr. F. Karsch, and published by R. Friedländer & Sohn in Berlin. It is apparently improved, and No. 1 for this year is illustrated by a plate, with two wood-cuts. Dr. Ernest writes to it from Caracas, "we have here the locust plague! *Acridium peregrinum* in immense swarms. The eggs are infested by a small hymenopter, *Scelio famelicus* Say," noticed in the second report United States Entomological Commission, 270.

—A first duplicate of the "Philip Carpenter collection" of shells, reserved by the late Dr. Carpenter for private use and study, remains in possession of his widow, Mrs. Carpenter, 241 University street, Montreal. It contains, according to a catalogue accompanying it, 4039 species. There is also one of the best duplicates of the "Mazatlan collection" of Dr. Carpenter. These collections will be disposed of on reasonable terms, more especially to any public collection or working naturalist.

—*Nature* Nov. 20th, 1884, p. 72, contains a report of the Academy of Sciences, Paris, on the depth to which sunlight penetrates the waters of Lake Geneva, by MM. H. Fol and Ed. Tarasin. From a series of experiments carried out in August and September of that year, the author concludes that light reaches a depth of 170 meters, and probably a little more, the luninosity at this point being about equal to a clear moonless night.

— The first part of a detailed and well illustrated work on the embryology of Peripatus, by Dr. J. Kennel, appears in the Arbeiten aus dem Zoölogisch-Zoötomischen Institute in Würzburg. Bd. VII, Heft 2. The six folding plates are packed with illustrations which show, without undervaluing the labors of Balfour, that this memoir will be the fullest and most important yet published in the development of this exceedingly curious creature.

—Mr. A. Agassiz, the director of the Museum of Comparative Zoölogy, has distributed to correspondents in this country M.

Perrier's elaborate memoir on the star-fishes of the "Blake," dredged in the Antillean seas and Gulf of Mexico, under the direction of Mr. Agassiz. It appears in "Nouvelles Archives du Museum d' Histoire Naturelle, June 16, 1884.

For more than twenty-five years Professor J. V. Carus has been collecting materials for a general prodromus or preliminary view of the fauna of the Mediterranean sea. The first part has appeared, containing the Cœlenterates, Echinoderms and worms.

— Further experiments with the new anæsthetic, cocaine, have been made by M. Vulpian, and laid before the French Academy. Researches on snails and crawfishes show that it is less efficacious in the case of invertebrate then vertebrate animals.

— Of the Australian ants, *Formica rufinigra* is said to be the most numerous, bold, and destructive. It destroys the web of certain caterpillars, and wriggles them out, when they fall a prey to a host of attendant warrior ants.

— The death is reported of Mr. Alexander Murray, formerly director of the Geological Survey of Newfoundland, and author of a treatise on the geology of that island. His latest paper was a most interesting one on the glacial scratches of Newfoundland.

--Edward Rüppell died at Frankford, Dec. 10, at the age of 90 years. He was an explorer, geographer, and naturalist, his researches and travels having been made in Northeastern Africa and Arabia Petræa.

— We regret to be obliged to announce the sudden death, in January, by pneumonia, of Mr. Augustus Meisel, the well-known lithographer of Boston, who has produced most excellent zoölogical illustrations.

—M. Searles V. Wood, well known for his essays on English tertiary and quarternary deposits, died December last.

— The death is announced of Mr. Alfred Tylor, a well-known writer on geological and anthropological subjects.

— D. A. Keferstein, well known as a lepidopterist, died at Erfurt, Nov. 28.

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PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Society of Naturalists of North America.—This body met at Washington, in the lecture room of the National Museum, on Jan. 29th. The following papers were read:

29th, A. M.

1. Charles S. Minot. A new cabinet for microscopical specimens.
2. ——A new feeding trough.
3. ——An apparatus for calculating intervals of days rapidly.
4. S. H. Gage. The use of Müller's fluid for preserving the dark colors of animals.
5. ——The use of collodion for protecting the rubber rings of museum jars.
6. ——Glass bulb canulæ for the injection of silver nitrate, gold chloride, etc.

7. H. F. Osborn. A simple method of injecting the entire arterial and nervous systems in different colors.
8. H. P. Bowditch. A new form of stop-cock for rubber-tubing.
9. R. Ramsay Wright. On methods of staining series of sections.
10. B. G. Wilder. The use of slips in scientific correspondence.
11. C. S. Minot. On a new staining solution for histological use.
12. C. A. Ashburner. Notes on barometric hypsometry.

29th, P. M.

1. H. C. Lewis. A summer school of geology.
2. C. A. Ashburner. Methods in practical geology.
3. H. N. Martin. The use of modeling clay to illustrate lectures.
4. H. F. Osborn. Methods of investigating the embryology of the opossum.
5. Theo. Gill. On osteological collections.

30th, A. M.

1. C. D. Walcott. The collecting and working of invertebrate palæontologic material.
2. G. K. Gilbert. Geological bibliography.
3. Geo. P. Merrill. Exhibition of a colored, enlarged photo-micrograph of a thin section of a rock.
4. G. Brown Goode. Account of the unit system of cases used in the U. S. National Museum.
5. J. A. Ryder. On museum alcoholics.
6. Wilder and Gage. An investigator's table with double or triple revolving top, and movable book-rests.
7. R. R. Wright. On the use of series of sections in laboratory teaching and a convenient method of obtaining them.

30th, P. M.

1. H. A. Howell. On the use of terrapin blood for the demonstration of the phenomena of coagulation.
2. Harrison Allen. Exhibition of the palatograph.
3. C. V. Riley. On the mounting of alcoholic specimens in insect cabinets.
4. ——On a preserving fluid for soft galls and plant tissues.
5. John Murdock. New application of the towing net in the Arctic regions.
6. F. W. True. On the preservation of type specimens.
7. G. B. Goode. The use of photography for making large diagrams.
8. W. H. Niles. Shall we define groups of organisms?
9. L. F. Ward. On a method of rapid drawing for photo-engraving.
10. R. E. Call. Dentition of certain mollusks.

Biological Society of Washington.—The fifth anniversary meeting of the Society was held Jan. 24, 1885. The retiring president, Professor Charles A. White, delivered an address upon the application of biology to geological history.

New York Academy of Sciences, Jan. 12, 1885.—Mr. B. B. Chamberlain read notes on minerals from the French Creek mines, Chester county, Penna. (with exhibition of specimens).

Jan. 26, 1885.—The plan of the Mississippi River Commission and its relation to natural laws, was discussed by Mr. William L. Elseffer, C. E.

Boston Society of Natural History, Jan. 7, 1885.—Professor W. O. Crosby read a paper on the color of soils.

Jan. 21.—Mr. Percival Lowell described the costume characteristics of the Coreans; and Professor Edw. S. Morse spoke of Corea as seen through interviews with a native Corean.

APPALACHIAN MOUNTAIN CLUB, Jan. 8, 1885.—Mr. T. W. Bicknell described a summer trip to Alaska, with lantern slides, illustrating the topography of the Northern Pacific Railroad, Alaska, its products, mines, people, houses, dress, customs, social and religious, seals, glaciers and icebergs.

Jan. 14.—Annual meeting. The reports of the secretaries and the treasurer were presented, and the annual election of officers held. W. H. Pickering presented a paper, illustrated with the lantern, entitled an ascent of Vesuvius on the Pompeiian side.

AMERICAN GEOGRAPHICAL SOCIETY, Jan. 13, 1885.—Professor F. H. Cushing, of the Smithsonian Institution, who has dwelt for some years among the Zuñi Indians, delivered a lecture upon his explorations and researches on the discovery of Zuñi or the ancient province of Cibola and the seven lost cities, illustrated by ancient costumes, paraphernalia and stereopticon views.

PHILADELPHIA ACADEMY NATURAL SCIENCES, Nov. 13.—Dr. Randolph stated that he and Mr. S. G. Dixon had experimented on cutaneous absorption by placing one to fifteen drops of nicotine on the breasts of rabbits, taking care to previously remove the hair without abrading the skin. Death resulted in from half an hour to four hours, and nicotine was found in the blood before death, proving that it was absorbed by the uninjured skin.

Nov. 20.—Dr. Leidy presented specimenns of *Urnatella gracilis*, showing that at the approach of winter the polyps die, the stalk alone remaining securely anchored and ready to reproduce in spring from the summit of the terminal joint. Mr. Potts stated that he had seen examples with seventeen joints, and that the number seemed to be limited only by the time of growth. The latter speaker also describes a rhizopod, apparently a new species of the genus *Acanthocystis*. It was collected on mica schist west of the Schuylkill. The protoplasm filled about one-third of the cavity of the capsule.

Professor Heilprin called attention to a boulder found at Summit, N. J., and containing *Atrypa reticularis*, a form of Strophomena, and several other species, proving that the material came from the Lower Helderberg, the nearest locality of which is sixty miles from where the boulder was found, while the nearest locality in the direction of the glacier's movement was at least a hundred miles.

Nov. 27.—Mr. Ford detailed the finding of *Pholas truncata*, Pierispata, and *Littorina irrorata* upon the beach at Atlantic City, also the discovery of capsules of *Fulgur carica* with living embryos. The Rev. Dr. McCook described a collection of the towers of turret spiders, some made with cotton and other materials supplied to them, others with their own materials. The work of individuals which have just emerged from the egg shows that at that age their instincts are perfectly developed.

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